

• KYABRAK

197 RONGBUK MONASTERY

MAP of the KHUMBU REGION

28°10'

■ DZA RONGBUK

Gyachung - Glacier

Kyetrak - Glacier

6888 PALUNG RI

CHO OYU

NANGPA LA

5500

LADE

LUNAK

GYACHUNG KANG

7922

NUP LA

West - Rongbuk Glacier

North - Rongbuk Glacier

East - Rongbuk Glacier

KHARTA CHANGRI

7082

Kharta - Changri - Glacier

KHARTA PHU

7221

LHAKPA LA

6766

KARPO LA

KARMA CHANGRI

6266

LINGTREN

6697

PUMO RI

LHO LA

6006

CHANG LA

6985

RAPHU LA

6510

MOUNT

EVEREST

8848

SOUTH COL

7986

NUPTSE

7879

LHOTSE

8501

PETHANGTSE

6724

CHOMO LONZO

7815

KANGCHUNG TSE

7660

Barun - Glacier

MAKALU

8470

BARUNTSE

7220

ADABLAM

6856

PHERICHE

4000

PANGPOL

DEVUCHE

THYANGBOCHE

3960

PANGAR

MACHHERMA

KHUMBUYOLMA

LAPHARMA

PHORTSE

KUNDE

KHUMJUNG

3880 ■ NAMCHE BAZAR

THAMICHOK

THAMI

KWANGDE

THYANGBO

KEROK

HELAJUNG

KAPSALE

TARANGA

MARALUNG

CHHULE

BRUTE KOSI

GOKYO

Ngayumba - Glacier

Khumbu Glacier

Kangchung - Glacier

Map of Everest Region

0 5 10 15 20 km

86°50'

87°30'

86°40'

27°50'

28°00'

MOUNT EVEREST

*Formation, Population and Exploration
of the Everest Region*

TONI HAGEN
GÜNTER-OSKAR DYHRENFURTH
CHRISTOPH VON FÜRER-HAIMENDORF
ERWIN SCHNEIDER

Translated by
E. NOEL BOWMAN F.R.G.S.

LONDON
OXFORD UNIVERSITY PRESS
NEW YORK TORONTO
1963

Oxford University Press, Amen House, London E.C.4

GLASGOW NEW YORK TORONTO MELBOURNE WELLINGTON
BOMBAY CALCUTTA MADRAS KAPACHI LAHORE DACCA
CAPE TOWN SALISBURY NAIROBI IBADAN ACCRA
KUALA LUMPUR HONG KONG

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English Translation

© OXFORD UNIVERSITY PRESS 1963

*Mount Everest – Aufbau, Erforschung
Und Bevölkerung Des Everest – Gebietes*

was

Originally published in German
in 1959 by

ORELL FÜSSLI VERLAG, ZÜRICH

PRINTED IN GREAT BRITAIN

PREFACE

It falls to one who has never seen the Himalayas to write the preface to this book on Mount Everest. But it is in accordance with the wishes of fellow mountaineers and friends, for this book about the Himalayas, 'the roof of the world', is a milestone in the literature of this area in which so many mountain enthusiasts have climbed and about which many books have been written. It is quite out of the run of the usual type of literature concerned with the area; in fact it can be considered as the best book about the Himalayas and in any case is the most comprehensive work on the scientific research of the Everest massif.

The chronological history of the mountain exploration of the Everest range is by itself a document of permanent value, which could only be compiled by one who is known to us as the 'High Priest' of the Himalayas, the traveller and explorer, Günter-Oskar Dyhrenfurth.

Dr. Toni Hagen spent eight years wandering through the Nepal Himalayas, along the valleys and over the high passes which cross this huge mountain barrier of Asia. On behalf of the Technical Assistance Administration of the United Nations and the Nepal government he made a geological survey and produced a geological map of the area. In his clearly defined description of the evolution of the highest mountain in the world, he offers an interpretation of the mysteries of the earth's crust which can be grasped by the non-technical mind. We are shown how the geologist sets about his work and learn how the massif rose out of the Himalayan Sea in the dawn of history to form the mountain range which we know today. Toni Hagen has the ability to bear the reader with him upon geological excursions and make him believe that he is actually a member of the party. The cross-sections, sketches, and pictures help the reader to understand and form an opinion on the geological and tectonic aspect of the Everest range.

Prof. Dr. G. O. Dyhrenfurth's chronological survey does not only record the various attempts on the peak, but relates how for decades climbers had been attracted by this huge mountain chain and had endeavoured to penetrate the icy fastnesses of the 'Chomo-Kangkar' or 'Chomo-Lungma' of the Tibetans. As Dyhrenfurth indicates in his book *The Third Pole*, 'Chomo-Kangkar' is the mountain of the 'Mother-Queen-Snow-white', the 'White Snow of the Mother-Queen', and 'Chomo-Lungma' is the 'Goddess-Mother of the World'. The inhabitants of these barely accessible valleys regard the highest mountain as the altar of the

deified ruler of their country. Upon the unattainable summit lay the infinite purity of the eternally white snow. What magic lies in its original name when compared to the prosaic 'Peak 15', as it was called when the survey of the area was carried out during the Survey of India in 1845-50, from the plains on the southern side of the Nepal Himalayas. Even the British eventually realized that the highest mountain the world was worthy of a better nomenclature, so they called it Mount Everest in honour of the head of the Survey Department, Sir George Everest.

Prof. Dr. Christoph von Furer-Haimendorf takes us with him on his wanderings in the Everest domain and shows us the life, habits, villages, and country of the Sherpas. He shows us how important it is that the climber should not only visit the Himalayas on account of the glaciers and rocks, the 7000 and 8000-m. peaks, but should remember that it is an inhabited country, the habits and customs of which are well worth careful study. He points out that this mountain people, in spite of the vast difference in race and religion, in many ways bears a resemblance to the Alpine peasants. Our mountain folk are equally dependent upon alpine husbandry, laborious agriculture, trade over the passes, and acting as guides and porters. The Sherpas, moreover, have the same thirst for freedom and independence as have the Alpine peoples and their communal lands and democratic village administration are similar to our village communities and communal pastures. This is an excellent example of how the mountain temperament moulds mankind and customs regardless of time or place.

At the end of the book, Erwin Schneider, topographer, gives a brief description of the Everest map, without which no Himalayan traveller of the future will venture into the area of the 'Third Pole', as Dyhrenfurth has so aptly designated this mountain range. It is indeed a 'cartographical event', as Marcel Kurz said when it was published. The accuracy of the photogrammetric method of survey and the artistic and masterly reproduction, especially of the rocks and glaciers, has created a map which stands out like a relief.

Let us hope that this book will attract many readers, so that apart from climbing, which is dealt with in a variety of books on the Himalayas, they will learn something about the scientific exploration of these mountains, which is still going on and will continue for years. Thanks to the co-operation of the following bodies, the German Alpine Club, the Austrian Alpine Club, and the German Research Society (*Deutsche Forschungsgemeinschaft*), which produced the Everest map, this book has seen the light of day and the price has been kept down to reasonable limits thanks to generous donors, among whom we would particularly single out Dr. Otto Wenger and Herr A. Sutter. Last but not least, thanks are due to the

tireless and self-sacrificing labour of the authors and the Orell Füssli Verlag for their splendid work.

In the high mountain ranges of the Himalayas a climbing rope can only achieve something worth while when guides and guided, Sahib, Sherpa and porters work together as a team, and in the main the same principles apply to the scientific exploration of all countries and mountain ranges.

May this book afford many readers much pleasure.

Altdorf-Uri
Spring 1959

MAX OECHSLIN

A NOTE ON THE SPELLING OF TIBETAN PLACE-NAMES

The Sherpas speak a Tibetan dialect. The Tibetan language belongs to the Tibetan-Burman sub-group of the Sino-Tibetan tongue; it is isolated with word roots of one syllable. Tibetan is probably the only language in which the written word differs from that spoken even more than in English, for the Tibetans are even more conservative. They have obstinately retained the form of writing of the seventh century A.D., while the pronunciation has changed very considerably. The correct style, pronunciation, and importance of Tibetan place-names often provides a problem over which linguists wrangle for years.

For example, since 1921 nobody has agreed upon the correct native name for Mount Everest, of which I append a few samples:

Kang Cha-mo-lung	Snow of the Bird Country. (Sir Charles Bell.)
Jo-mo-lun-ma	Goddess of the Wind or Bird of the Wind. (Dr. Schubert, Leipzig.)
Chomo-lungma	Goddess Mother of the World. (Survey of India.)
Chomolongma	Same meaning but phonetically more correct. (Suggestion by P. Aufschnaiter who lived in Tibet for seven years and speaks good Tibetan.)

A further example: the Tibetologist, D. L. Snellgrove, considers Rongbuk incorrect and prefers Rongphu. The pronunciation of the two words does not differ as much as one would think, for *ph* is not pronounced like *f*, but more like *p* or *b* followed by an aspirated *h*. Perhaps Rongphu is actually more correct; but all maps, including the new Schneider-Ebster map of 1957 and the whole of the Himalayan literature for the last forty years, have referred to the Rongbuk Monastery, the Rongbuk Glacier, etc. I have scruples about changing all that in favour of a new theory.

A third example refers to the celebrated Monastery on the south side of the Everest group, which appears on all official maps as Thyangboche. On the advice of Tibetologists this was changed to Thangpoche; it is now said that *Tengpoche* is the correct version. In my view it would be better to write it as *Tengpoché*, otherwise it will, inevitably, be pronounced as *Tengposh*.

The differences in style of the four authors of this book have led to variation in the spelling of the names mentioned above. A footnote will found where they first occur in the text.

G. O. DYHRENFURTH

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 3, 6, 7, 16, 21, 23: *Erwin Schneider*

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MAPS

Front end-paper Map of the Khumbu region

Folding Map The Mount Everest area *in pocket at end*

1

THE EVOLUTION OF THE HIGHEST MOUNTAIN IN THE WORLD

Toni Hagen

I. FULFILMENT OF A YOUTHFUL DREAM

I first came under the spell of the Himalayas after attending a fascinating lantern lecture delivered by the well-known Dutch Himalayan explorer, C. Visser, before the Thurgau section of the Swiss Alpine Club, in the early nineteen-thirties. From that moment I was obsessed with the desire to explore the Himalayas myself but for a long time it seemed as though my wish would never come true, for none of the mountaineering expeditions at that time could be bothered with a scientist in their party.

I shall never forget—it was in 1949 and I was occupied at the time with a photo-geological elaboration of aerial photographs with the stereo-autographer at the goedetie Institute of the ETH—when Walter Custer, subsequent head of the first Swiss technical mission to Nepal, came in and said, ‘You’re the man we want as geologist in Nepal.’ Two years later, in 1950, I found myself in a first-class railway compartment on the way from Calcutta to Raxaul, the terminal station on the Nepalese frontier. Although the frontier was 300 kilometres distant, the giants of the Himalayas stood out above the Ganges plain in the clear autumn evening—an unforgettable sight.

The first Swiss technical mission was limited to a maximum of six months and in this space of time I was able to make my first geological cross-section from the Ganges plain to the Tibetan frontier. This however sufficed to produce proof of the overthrust structure of the Nepal Himalayas. My appetite, as well as that of the Nepalese government, was whetted by these first results for further systematic exploration of the country. Just ten days before the expiry of my return air-tickets, the Maharajah sent for me and said, ‘We shall give you a direct contract, to continue your work in our country.’ As there was no time to correspond with my family in Switzerland, I accepted on the spot.

This was undoubtedly one of the most gratifying examples of geological exploration still left in the world. On the one hand it was a completely

unknown land, still appearing as a blank spot on the latest geological maps of Asia, and on the other hand one of the most geologically interesting regions, containing the highest mountains in the world.

The arrival of the government delegation at the Guest House actually caused a minor crisis, coming as it did exactly ten minutes before I would have to leave if I were going home. If I had delayed any longer I would have missed the connection in India and the return tickets would no longer have been valid. Colonel Rana, the Director of the Nepal Bureau of Mines, headed the delegation which had brought the contract for my signature.

A few months later I was once more sitting in an aircraft of Air India International, watching the lights of Geneva—symbol of solid Swiss security—disappear behind me in the darkness. Since my previous visit to Nepal there had been a revolution involving civil war, the outcome of which was as yet uncertain, and my journey to the East was in more than one respect a journey into the unknown.

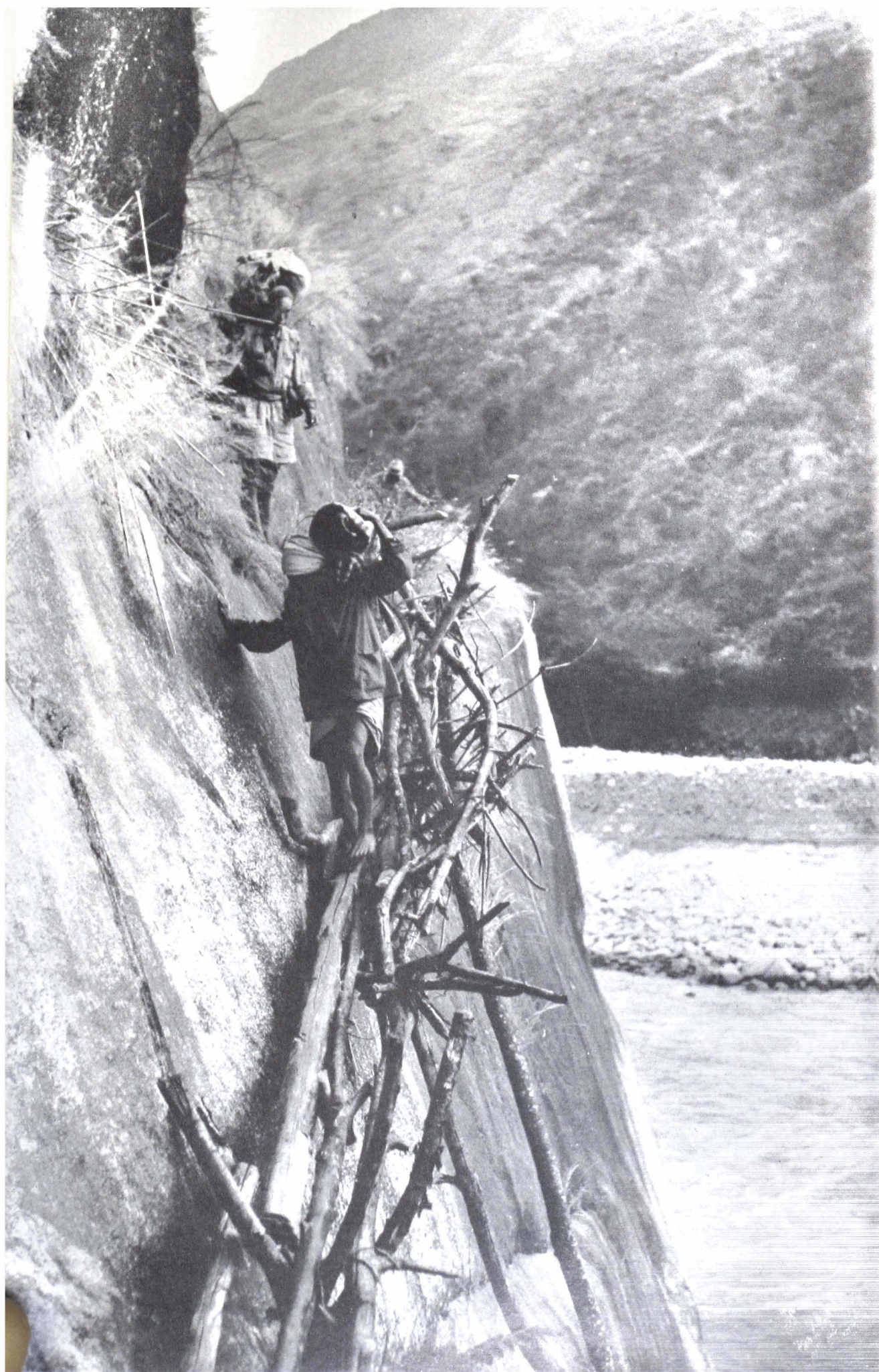
My family was not able to follow me until nine months later, by which time I had managed to find a suitable house. Fired by my enthusiastic description of the wonderful country and the friendly people, my stout-hearted wife embarked on the journey to the far-off Himalayas with three small children and in a state of suppressed excitement.

At first, on short expeditions in the vicinity of Kathmandu and Pokhara, I used to take my family with me. The children were conveyed in carry-cots and they loved camp life. I could not do this in the case of longer expeditions, and this, as the following anecdote will testify, they greatly regretted. We had set up our camp in Pokhara, south of Annapurna, and the children were sleeping in their own little tent. One morning, just before dawn, we heard a quarrel going on between six-year-old Christoph and four-year-old Katrin. They were slanging each other unmercifully and finally Katrin produced her worst retort, saying to Christoph, 'I hope God makes you a geologist.' My wife and I looked at one another in perplexity and later on we asked Katrin what she meant by this surprising remark. She answered quite simply, 'Well, you see, geologists have to be away from their families so long!'

The fears expressed in Katrin's remark turned out to be true only too soon. After the area around Kathmandu had been worked out, my journeys took me into far-distant and remote parts of the country to the west and east, and as it was necessary to get there on foot, they lasted some time. With a heavy heart I was obliged to send my family back to Switzerland, after a stay of almost two years in Nepal, as otherwise they would have been alone in Kathmandu for most of the time. Schooling was also another problem and at last my wife and children had to leave, though she

PLATE I. Mount Everest, 8848 m., seen from the south-west. The mountain was first climbed in 1953 by E. Hillary and the Sherpa Tenzing up the right-hand ridge. In the centre of the picture is the west *arête* of Nuptse





was loath to say farewell to the beautiful country which she had come to love like a second home.

During the course of the next six years of geological exploration in the Nepal Himalayas (from 1953 on behalf of UNO's technical assistance for under-developed countries) the whole of Nepal was mapped geologically on a scale of 1:250,000 (Quarter-Inch Map of the Survey of India). On 26 March 1958 the last gap in the network was filled in by a sketch on the Sakha Pass, a few kilometres to the east of Jajarkot in west Nepal. The last tap with a geological hammer, and the last geological entrance in the field book, took place south of Pokhara on 12 April 1958.

Ninety-six geological cross profiles of 1:100,000 from the Ganges plain to the Tibetan frontier were completed, but tens of thousands of sketches and photographs await elaboration. The completed subject matter was published in a book of several volumes by the Geological Survey of India. Nepal will shortly possess the first geological map in its history, in the form of a general map on the scale of 1:400,000. The territory covered comprises 141,000 square kilometres, about four times the area of Switzerland. In order to achieve this it was necessary to cover more than 14,000 kilometres on foot horizontally and more than 950 kilometres vertically. In all, 1,860 days were spent in tents.

When, further back, I talked about 'filling in the last gap', this referred only to the 'preliminary' geological map of Nepal, within the limited objects of my survey. A geological map can never be considered as finished and in Nepal we are only beginning our geological exploration. My map will serve as a useful basis but is subject to change. In Switzerland there have been geological maps in existence for over a hundred years. Nevertheless the pundits have recently been arguing over the basic problem of whether or not the Gotthard is a massif or a nappe.

2. GEOLOGY, GODS AND DEMONS

The Himalayas play an important role in the legends, fables, and religious beliefs of the neighbouring peoples. This inhospitable and barren mountain chain, the source of the great rivers, assumes in part the significance of a dispenser of nourishment, as indicated by the name Annapurna. Above all, however, the unattainable lofty summits were regarded by men as the dwelling place and throne of the gods. This is clearly expressed in a variety of names; for example, Chomolungma for the highest mountains, the Everest-Lhotse group. Chomolungma is the Tibetan and therefore aboriginal designation, meaning 'Goddess Mother'.

The local population regards the mountains with reverence, fear, or horror, according to their religion or their linguistic-ethnological association.

PLATE 2. The important north-south trade route in the Arun Gorge, near Sempung

The only people really at home in the mountains are the Tibetans who dwell north of the main chain and the Sherpas closely allied to them, who live on the southern slopes of the Everest group. The Sherpas have for hundreds of years driven yak trading caravans over the high, often snow-covered, passes to Tibet and during the summer months pursue a pastoral existence in the high pastures up to an altitude of 5300 m. In their capacity as shepherds they often climbed small peaks above the pastures or the summer settlements in order to set up large cairns with prayer flags in honour of their gods. According to their beliefs, these cairns form a protection for man and beast against bad weather and other calamities. The prayer flags can be compared to the mountain crosses in the Alps.

The expression 'familiar with mountains' as applied to the mountain dwellers of this country, merely refers to their inurement to the arctic conditions and the height, their contentedness with the meagre food (they live almost exclusively upon *tsampa*, barley flour) and their withstanding of months of solitude. The urge to explore and discover new terrain requires to be developed in them. That anyone should want to climb a high mountain solely for pleasure, is, at the present time, simply not understood by these mountain peasants.

The exceptions are a few Sherpas who have developed a feeling for the beauty of the mountains and have discovered the pleasure of conquering peaks, owing to repeated participation in expeditions. This is especially in true the case of my own Sherpa, Aila, who was my companion for seven years. Often when we were sitting on a summit with a magnificent panorama spread out before us, he would say very dryly, 'Very much country, sir.' This was his way of expressing his pleasure at the wonderful view. Latterly he went so far as to say, 'Very beautiful country, sir.' There was a wealth of enthusiasm behind these terse remarks.

The current situation in Nepal might well be compared with that prevalent in Switzerland a hundred years ago. In those days, it was the British who gave the impetus to the mountaineering exploration of the Alps, for it rarely occurred to the local inhabitants in those far-off days to climb the inhospitable heights for pleasure. The best and most enterprising of the shepherds were engaged by the English as guides and porters, and from these small beginnings sprang the Swiss *corps-de-guides*.

India has made a very promising start towards the formation of such a corps, with the Mountaineering School of Darjeeling, where the Sherpa Tenzing, who climbed Everest, plays a leading role. It is to be hoped that Nepal also, the home of the Sherpas, will seriously take up the training of climbers through the recently formed Himalayan Society.

Demons and evil spirits dwell in the Himalayas, according to the peoples of the Tibeto-Burman and Indo-Aryan language groups living on

the south side of the main chain. I encountered repeated examples of this with my own porters, one instance of which I quote herewith. One very hot day in May 1954, while marching along a barren, dried up valley (the Uttar Ganga), one of my porters had a sudden attack of heat stroke accompanied by long bouts of unconsciousness with frequent relapses. Injections of coramine, however, got him on his feet again within a few days. The successful application of my treatment was contested by the other porters, and one of them, a Tamang-Lama, in order to propitiate the gods, made an offering of a hen with rice accompanied by a very special ritual. Nevertheless he marched along with me over high passes for many months afterwards, without any further ill effects.

Four years later, in January 1958, at the end of a march of many thousands of kilometres, we passed through the same valley again, this time, however, on the other side of the Uttar Ganga River. We pitched camp within 300 m. of the scene of the incident in 1954. For days the porters who were there in 1954 had been regaling the few newcomers to the party with grisly stories of the evil spirits and what they had accomplished hereabouts, that only prayers and sacrifices had induced the demons to spare the unfortunate porter. Here I might mention that the Tamang-Lama was still with us. I was sitting at my field table, making notes in my field sketch book and the Sherpas were busy gnawing goat bones, for I presented them with a goat every ten days. Quite suddenly, without any warning, one of the porters, with his bone still in his hand, fell sideways from his squatting position, unconscious. There was a frightful to-do about this fresh intervention of the spirits and even my Sherpa, Aila, who normally in the most critical situations invariably said with a cheerful grin, 'All right, sir,' now ran up to me in an agitated manner and said, 'Very bad, sir.' When the rest of the porters had recovered from their initial shock, they scattered in all directions in order to reach the nearest village as soon as possible and make propitiatory sacrifices.

Even I felt that the situation was exceedingly unpleasant, for Aila said again, 'This valley bad, sir, many people falling down like this, sir.' I rather expected to see all my porters fall down like ninepins at any moment and I at once gave the order to get moving out of reach of the evil spirits. The demons were expelled from the body of the unconscious porter within ten minutes with the help of coramine injections but, notwithstanding this, the rest of the party sacrificed a large number of hens to be on the safe side. In the first case of heat stroke, four years before, there had been symptoms of complete cessation of the pulse, followed by great irregularity in its action, whereas now the heart was operating normally.

Not all encounters with demons ended so happily, however, for my

first incursion into the Everest region in 1954 had tragic results. Two days before crossing the 6000-m. Tesi Lapcha Pass, the entry into Khumbu from the west, one of my Tamang porters gave all his money and possessions to his friend to take to his relatives, as he felt that he would not cross the pass alive. The next two nights, encamped below the pass, he cried for his mother, and injections of coramine, which were given him for supposed mountain sickness, were of no avail. I wanted to send him back with two other porters but he emphatically refused to go. Fifty metres below the top of the pass, in beautiful spring weather and sunshine, he lay down and, although he showed no outward signs of illness, died within half an hour.

Before I went on any more expeditions, I took advice from a doctor friend of mine, with the result that I almost certainly saved the lives of porters on two subsequent occasions by weakening their determination to die by timely injections of morphia.

The Newar, a national group living in the valley of Kathmandu, attribute the formation of the valley and the origin of their culture to the direct intervention of a god. According to a religious legend, the present valley of Kathmandu used to be filled by a large lake. When Manjusri, a Bodhisattva from north Tibet, and his companion, the bird-god Garuda, saw the lake, the former made a notch in the Mahabharat chain with his sword to make an outlet for it. In this manner was formed the valley of Kathmandu. Geological science has proved the existence of the lake and fossilized elephant bones found there have determined its age as of the pleistocene era.

The popular conception of the Himalayas as the home and throne of the gods explains why the inhabitants consider them to be rich in minerals. For where the gods dwell, so they think, there must be gold and precious stones. Particularly valuable are the alleged miracle-working gems, called saligram. These are black 'marbles' in which the gods are supposed to have inserted gold. Fantastic prices are asked for these objects and there is a thriving trade in them in India. I was extremely interested in these saligrams and went to great trouble and expense to acquire some of them. This was not on account of the alleged miraculous properties or the gold content but because these saligrams are concretions which have formed around fossilized ammonites in globular form. Often the core of these ammonites contained pyrites (the gold). No saligrams are to be found on the Nepal side of the Everest group, as the appropriate rocks (trias to chalk) are not present. They are, however, found north of the chain and are brought south by trading caravans.

Not only the simple natives believed in the rich treasures of the Himalayas, for some of the ministers of the old régime, under the Maharajah who allowed me to come to Nepal in 1950, regarded geologists as

some sort of modern treasure seekers. They were supposed to be seeking the alleged gold and it was with some astonishment that they perceived that the geologists emerged from the mountains, not with boxes full of gold, but bearing field books containing geological cross-sections, coloured maps, and apparently valueless rock samples.

I can only attribute the fact that I was able to convince the government fairly soon that a geological map formed the basis of every discovery of the natural treasures of the country to a change in the government itself. Above all I am indebted to my very good friend, Colonel K. N. Rana, former Director of the Nepal Bureau of Mines, for the fact that I was allowed to carry out an uninterrupted systematic survey of Nepal right through to the end.

The most unpleasant part of my whole task and one which I personally detested, was that I was obliged to shatter beautiful dreams and idealistic conceptions with the realistic principles of modern science. Nepal undoubtedly possesses great natural riches but they do not exist in the mountains and consequently have nothing to do with the Throne of the Gods. I am convinced, however, that the new scientific-geological knowledge concerning the build-up and evolution of the highest mountains is no less noble and magnificent than the hitherto existing conception of the treasure chamber of the gods. The omnipotence of the Creator cannot be conjectured in the face of the coming into existence of the epochs and forces which led to the genesis of the highest mountain in the world.

The lamas of the Thyangboche Monastery look upwards with awe and amazement towards Chomo-lungma,¹ the Goddess Mother of their country. How much more must modern man be amazed when he realizes, as he must, his own complete insignificance in relation to the scale of epochs and forces which have contributed to the development of the history of the universe?

Before we touch upon the scientific analysis of the most sublime mountain in the world, I should like to quote a poem emanating from the time-honoured Rig-Veda. This poem exalts the creation of nature by the omnipotent god Indra.

The mountains are the oldest descendants of the creator god, Prajapati. They had wings, with which they flew about, alighting where it pleased them. Indra cut off their wings and made fast the earth with the mountains. The wings which had been cut off became storm clouds, which is why they float above the mountains, for that is where they belonged. For that reason it rains more in the mountains than anywhere else.

Indra is regarded as the creator of the mountains and the liberator of the rivers from the dungeon where they were held captive by the dragon

¹ See note on Tibetan places-names, p. ix

Vritra (called Ahi in the poem). He created beds for the rivers with his thunderbolts. The rivers hurrying down to the sea are compared to herds of cattle. Here follows the third verse of the poem:

*The God yet scarcely born, with a bold heart,
Was first to waken courage in the Gods,
Before whose breath both worlds indeed did quake,
Because of his strength—that is Indra, O my people.*

*He held fast the shaking earth,
And caused the staggering mountains to stand still,
A limit set he to the free airs and to the heavens
Gave support—that is Indra, O my people.*

*The Ahi struck, loosing the seven streams,
Brought forth the herd from the cave's depths,
And fire made twixt earth and heaven.
A plunderer—that is Indra, O my people.*

*Heaven and earth before him make obeisance,
The mountains shake before his very breath,
He created the sun and the rosy dawn,
A leader of the waters—that is Indra, O my people.*

3. MOUNTAIN BUILDING IN THE COURSE OF THE EARTH'S HISTORY

It would not be out of place to introduce here a few pertinent remarks concerning the formation of mountains in the course of the history of the earth. It will also help understanding of the story of the origin of the highest mountain in the world, as described in this book. At the same time it must be stressed that there is as yet no comprehensive explanation of the forces involved in the formation of mountains, for the pundits are still arguing about it.

The elucidation of mountains of volcanic origin did not present any insuperable difficulty to mankind. It was obvious to everybody how the earth had built up and how the molten interior was forced to the surface, forming ranges of mountains. It was also easy to understand that where it was not possible for molten material to force its way to the surface, the primeval forces down below were able to raise whole areas *en bloc*. This appeared to be confirmed by the finding of fossilized remains of animals, formerly living in the sea, on mountains thousands of metres above sea-level. Thus, even the bed of an old sea could by such a process be raised up and form a mountain chain.

New problems arose, however, when the stratification of the mountains, that is to say the sequence of stratification, exhibited abnormalities; old sediments transformed into crystalline rock by reason of age-old bedding in the depths of the earth, were found on the tops of mountains, while below these old strata—stratigraphically below in geological terms—the youngest rocks appeared.

It is clear that queries as to the reason for the abnormal bedding did not arise until it was possible to develop accurate methods of determining the age of sedimentary strata. The classic but indirect method is that of petrifaction. Every era of the history of the earth has its own characteristic flora and fauna. The science of the development of living creatures is called palaeontology, which has worked out a system of living creatures from the simplest form of amoeba up to man, and drawn up a corresponding chronological table. Whereas the tempo of biological development at the beginning of history was slow, it speeded up in the course of time and this acceleration is not only being maintained but is increasing. For in geological primeval times the same living creatures, e.g. the crustaceous trilobite, existed over a period of about 300 million years, while the saurians came and went in about 140 million years. According to the latest investigations of the Swiss scientist, J. Hürzeler, the first antecedent of man appeared approximately 10 million years ago. Some ten thousand years ago, man made the first tools; he conquered the seas hundreds of years ago, and the air a little more than half a century past. In a few decades he will have conquered space, but possibly by that time he will have again disappeared from this planet by self-extermination. Should that come to pass, then the logical continuation of biological selection—on a higher plane—would take place; that is if the beings on planets of other sun systems, whose existence should not be doubted, behave more intelligently and continue to develop.

Stratigraphy is derived from palaeontology and has brought this science into line with the stratification of the sedimentary rocks, thus establishing a chronological classification of these rocks. It will be seen from the above-cited speeding up of the development that the scale with which we measure the temporal course of biological development and therefore the history of the earth, is not a constant one. Whereas only a very large scale is available to us as regards the beginnings of world history, corresponding to the unaltered existence of certain types of living creatures over enormous periods of time, as we approach modern times, the scale becomes smaller. Modern archaeologists can pinpoint dates after thousands of years, solely by reason, for example, of a study of the living habits and tools of men, without finding it necessary to investigate the human element itself.

Side by side with the classical method of the determination of the age of rocks, has grown up a new direct process of determining age itself. This is connected with atomic physics. It has been discovered that during the radioactive fall-out of uranium and thorium, the fall-out products of lead and helium occur. The degree of enrichment of the fall-out products stands exclusively in relationship to the period of time. Thus, when compared with the still remaining original product in the same rock, uranium, it can be used as a means of determining the age of the rocks in question. So long as geologists had no means of determining the relative or even the absolute age of rock strata, there was no reason to expect anything else than that the oldest rocks would lie at the bottom, and the youngest and latest formed rocks at the top. Even when crystalline rocks were found lying above young sedimentary rocks, it was thought to be due to volcanic action.

One can well envisage the astonishment of the old natural scientists who, when climbing mountains, encountered young rocks on the way up and much older formations on the summit.

The most plausible explanation of this phenomenon was that it was an 'inverted series'. This opinion was arrived at by observation of the great rock folds in the Alps. Among these folds were many of great extent, having horizontal bedding, recumbent folds or nappes. The lower, 'recumbent' limb or 'middle limb' naturally exhibits an 'inverted series', with the older rocks of the fold core on top and the younger rocks of the edge of the fold, below. If the upper, normal part of the fold is eroded away, the example given can occur. The abnormal bedding conditions in the build-up of the Alps can be well explained by the theory of the 'recumbent folds' and their 'inverted middle limb'.

Even this theory experienced certain changes. With increasing detailed knowledge of the Alps, the 'reduced middle limb' proved more and more to be a product of the imagination. Almost all the large nappes in the Alps, known at the present time, have overthrust with their oldest strata along smooth-thrust planes, on to the youngest series of the tectonic unit lying immediately below. It is well known today that the great nappes did not arise from folds which then overturned and overthrust. On the contrary, the nappes developed from faults, the existence of which long before the actual formation of the mountains, had been proved by meticulous stratigraphical examination.

A nappe may be defined as follows: it is a mass of rock which at some point in the earth has been pushed for a long horizontal distance along a thrust plane. At the starting point of the fault, the nappe shows steeply inclined bedding, it is called the root zone of the nappe, or simply nappe root. It indicates the spot where the nappe makes contact with deeper

parts of the earth's crust, i.e. where it is pressed out of the earth, according to the prevailing theory. The central parts, which owing to overthrusting, have now become more or less horizontal are defined as actual nappes, while the most advanced parts are known as nappe fronts.

The development of the nappe theory occurred exclusively in the Alps, as this was the best-known mountain chain in the world. There was a bitter fight between the contending parties and the supporters of the 'fold' theory rallied obstinately to its support. A classic example is the 'Glarner double fold' of that past master of geology, Albert Heim. This will be dealt with in another section, for there are also Himalaya geologists who have created their 'Glarner double folds'. Even up-to-date geological publications are not free from the conception of the fault theory. Otherwise how could certain authors in the Himalayas still be advancing theories of 'inverted series' and 'inverted middle limbs'?

The geologist must have two basic criteria to enable him to study the form of construction of a mountain range:

1. The age of the rock strata.
2. The form of bedding (tectonic).

The classic and safe way of geological research is that of determination of age, i.e. stratigraphy. Assuming the presence of a large number of fossils affording a sufficiently fine stratigraphical structure, there is no difficulty in differentiating between normal and inverted series and in being able to separate tectonic units (nappes) one from another. Unfortunately there are large areas in all mountain ranges where there are no fossils, particularly in the case of metamorphic rocks. Here one is largely dependent upon conjecture and comparisons. A very detailed examination of the bedding sequence enables one to make lithological comparisons with similar formations in other terrains, where fossils have been found. When there are no fossils available, tectonic boundaries can be deduced by the presence of secondary characteristics such as the presence of a totally different type of rock, discordancies, shearing, folding, thrust planes with soil slip, zones of detritus, etc. There is, however, always an element of uncertainty about such an interpretation; for example, owing to a lack of fossils the geologist is forced to deduce the bedding sequence from the form of stratification. Results like this are largely hypothetical. There is only one case when it is possible to determine relative age by direct observation in the field and without the aid of fossils and that is when crystalline intrusions have either melted or broken through the thrust planes or folds. In this case the rise of the crystalline rock (as for example in Bergell granite) is indubitably younger than the formation of the mountain range.

Some time has been spent on this question as the south side of Everest is entirely lacking in fossils and consequently the structure in Khumbu is based solely on secondary characteristics.

The mountains of the world can be divided into uplift mountains on the one hand and folded and overthrust mountains on the other. While the uplift mountains comprise individual mountain groups or whole zones, the overthrust mountains on the other hand are arranged more in lines and are also known as mountain chains. But these mountain chains often produce zones without sliced structure such as, for example, the Mont Blanc massif in the Alps.

Volcanic mountains originated by means of uplift and natural accretion. The mountains of Tibet were also formed by uplift; for example, Kailas, the Holy Mountain, was found by A. Gansser in 1936 to have tertiary conglomerates with completely undisturbed bedding at 7000 m. above sea-level. In contrast to the type of mountain formed by uplift, horizontal thrust forces have also played their part in the overthrust mountains.

The immense height of the Himalayas is due to a combination of both characteristics. It is thus of secondary importance for us whether the dislocation of the rocks has occurred by means of active thrusting or is due to sliding along inclined planes, brought about by the action of gravity. Owing to good exploration work, which made it more easily visible than in any other mountain range in the world, the alternating play between the vertical uplift forces and the horizontal thrust forces in the Everest zone is of particular importance. Until now nothing had been forthcoming concerning the source of the forces and the ensuing movement mechanism of the mountains.

Everyone is agreed that the earth was once a molten ball, the surface of which cooled off and formed its present state. Even today the interior of the earth is in a sort of molten condition, proof of which is often given by volcanoes in a drastic manner (owing to the enormous pressures involved, a purely liquid state is not possible). The thickness of the solid crust of the earth is relatively small, in fact about 50 kilometres. Somewhat to their astonishment, the scientists found by means of seismic and gravity measurements that the crust was much thinner under the sea than below the continents. In fact under the Atlantic the crust cover is only a few kilometres and there is hardly any at all under the Pacific. The behaviour of the relatively thin, solid earth's crust on cooling down and the ensuing contraction of the earth have been likened by former scientists to the wrinkled skin of an apple. Like the apple rind, the thin crust of the earth was laid in folds. This was said to be the cause of the origin of mountains. There is, however, a flaw in this argument: the surface of the earth is the

part which cooled off and contracted the quickest; surely then, instead of subsiding in wrinkles and folds, it ought to have torn apart?

The ingenious Continental Drift Theory advanced by Alfred Wegener was of basic importance for further research into the history of the earth. According to this theory, the continents formed blocks which floated in the semi-molten interior of the earth. Although this theory had to be modified in detail, its basic conception still holds good. No scientist today contests the reciprocal drifting of the continental blocks, they drift away from one another in cyclic movements and come together again.

There is abundant proof available that the continental blocks not only assumed positions relatively opposed to each other in former geological eras, but that their position in relation to the axis of the earth had changed. Coal seams found in the Arctic, in Spitzbergen for example, came from a sub-tropical climate. Large areas of South Africa and especially India, showed traces of glaciation in carboniferous times. These areas therefore must have been much closer to the Pole at that time. It would appear that the continental blocks must have fluctuated between movements towards and away from the Pole rather than parallel to degrees of latitude. In the geological time of the Pole drift, troughs with inroads from the seas were formed, the so-called geosynclines. During this period massive sedimentation took place. At the time of the movement away from the Pole, the continents clashed together and the accumulated sediment in the geosynclines was pressed together, lifted up, overthrust and folded. On the occasion of the last collision between Europe and Africa, in tertiary times, the Alps were formed and the origin of the Himalayas dates from the clashing of Asia with the sub-continent of India. Geologically speaking, the Indian peninsula has nothing to do with the continent of Asia. It is a continental block having its own laws of drift. Geological research has shown that the history of the earth shows at least three great mountain building movements:

Caledonian formation (Silurian, about 410 million years ago)

Variscan formation (Carboniferous, about 280 million years ago)

Alpine formation (Tertiary, about 10-30 million years ago)

The Alpine formation includes the Alps, the greater part of the mountain chain round the Mediterranean and its sequence eastwards to the Himalayas via Turkey, Caucasus, Persia, and the Pamirs. The Alps and the Himalayas have a similar formation, although the Alps are overthrust from south to north and the Himalayas from north to south. Although they belong to the same universal tertiary phase of mountain formation, the Himalayas are younger.

When we inquire into the forces which brought about the continental

upthrust and formed the mountain ranges, we find ourselves on rather delicate ground. The movement away from the Pole of the continents is more and more attributed to the rotation of the earth and the resulting centrifugal force. Other scientists ascribe an important role to currents and eddies in the semi-molten interior of the earth. But there is no consensus of opinion even over the origin of such currents. Probably the storing-up of heat due to radioactive fall-out in the interior of the earth may have had a hand in it.

When all expressions failed, a new word was coined: isostasy. According to this theory, the earth's crust is always striving to achieve a state of equilibrium. When this is temporarily disturbed, e.g. by the formation of mountains, erosion of mountains or additional loading by ice caps during the Ice Age, the earth attempts to reach equilibrium again by upthrust, subsidence, and currents in the interior. The theory of isostasy really comes into its own when applied in the strict geodetic sense. In geology, the term is often misused, as in the case of the formation of Everest, as will be shown later. Undoubtedly the alternating play of forces in mountain-building is enormously complicated and very far from being elucidated by hitherto existing methods of research. It would be tempting to ask oneself what would happen if, after the sudden upthrust of a mountain, all movement of the earth's crust were to cease and only erosion allowed to play its part? Geologists assume that in such circumstances a mountain in the course of about 13 million years would be completely eroded away—i.e. 'peneplained'.

It is only recently that the Swiss geologist, Heinrich Jäckli, became more explicit on the subject. He has calculated that the average annual erosion would be in the order of one millimetre, based on observations carried out in the Grisons.

4. GEOLOGICAL RESEARCH IN THE HIMALAYAS

Following upon the general introductory remarks of the last section, which were for the benefit of the geological layman, we will now consider the progress of the geological exploration of the Himalayas.

The oldest geological sketch-map of the central Himalayas with accompanying cross-sections, dates from the year 1851 and was produced by Captain Richard Strachey, who had crossed the Himalayas a short time previously. His results (Fig. 1) are worthy of note, although they naturally did not show any overthrusting. Nevertheless, he noted the stratigraphical main classification and the prevailing northwards dip of the strata.

The journey of the Hungarian Professor L. von Lóczy in 1878 was of importance. His *Observations* were published in 1907 for the first time and

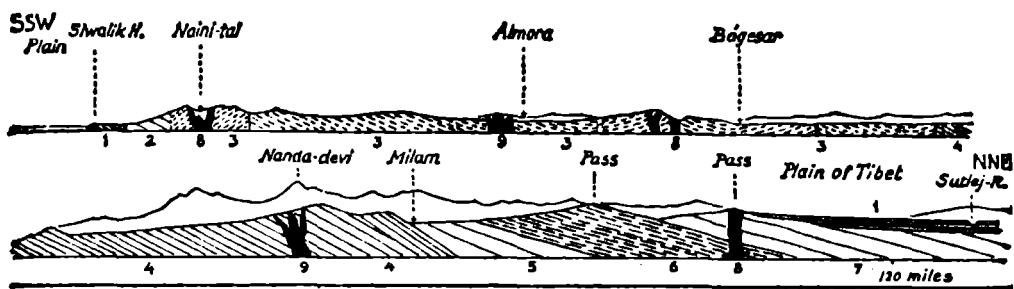


FIG. 1. First geological cross-section of the Central Himalayas. (Capt. Richard Strachey, 1851). R. Strachey was the first to note the northwards dip of the strata in the High Himalayas.

- | | |
|-----------------------------------|---------------------|
| 1. Tertiary | 5. Azoic formations |
| 2. Equivalent of the Krol (?) | 6. Palaeozoic |
| 3. Fossilized metamorphous strata | 7. Mesozoic |
| 4. Crystalline schist | 8. Green schist |
| | 9. Granite |

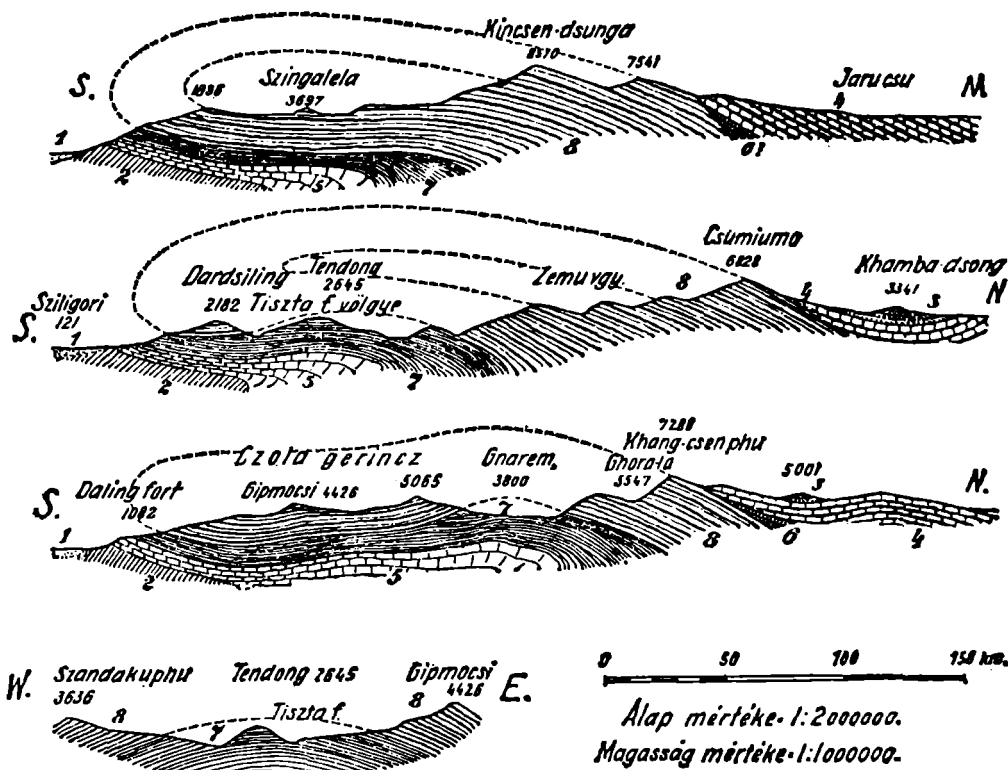


FIG. 2. Tectonic cross-section from Kangchenjunga to Darjeeling (L. von Lóczy, 1907). With his discovery of recumbent folds, he may be regarded as the originator of the overthrust or nappe theory in the Himalayas.

- | | |
|---------------------------|--------------------------------|
| 1. Ganges alluvium | 5. Equivalent of the Krol? |
| 2. Tertiary (Siwaliks) | 6. Palaeozoic? |
| 3. Tertiary (Tibet) | 7. Daling schist |
| 4. Mesozoic | 8. Darjeeling gneiss |
| (Alap mértéke—Base scale) | Magasság mértéke—Height scale) |

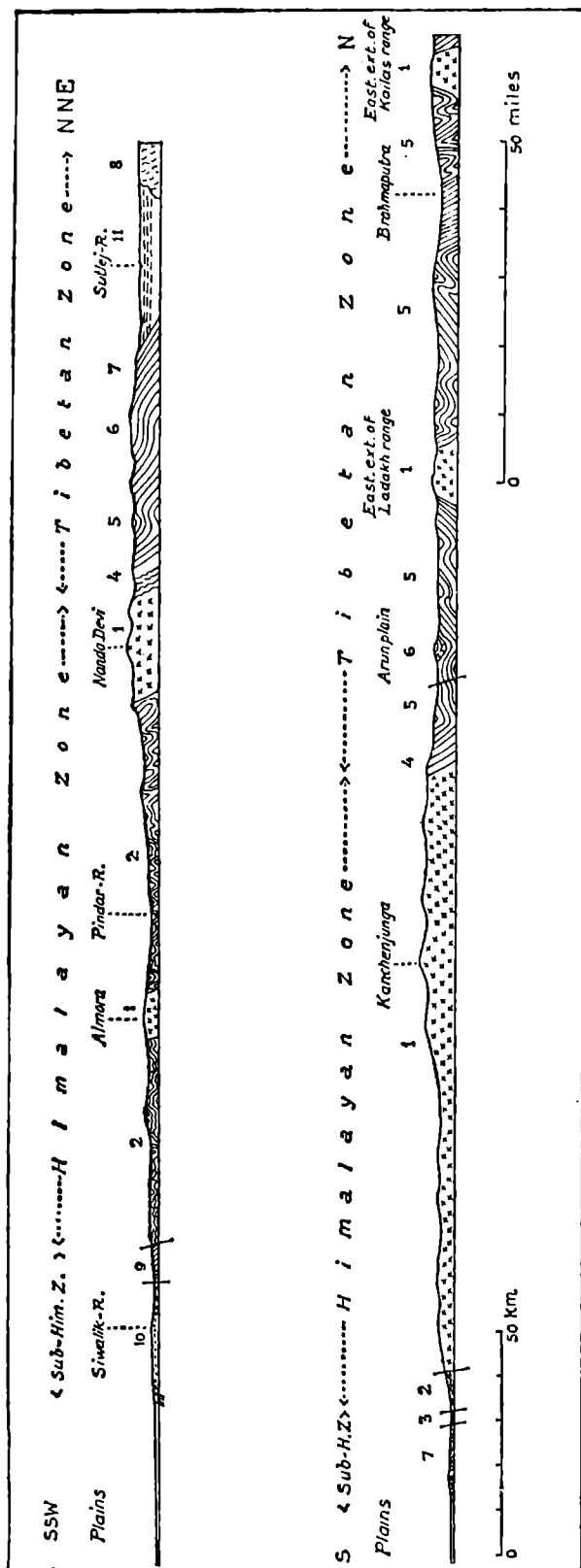


FIG. 3. Diagrammatic Section across the Himalayas (Burrard and Hayden's *Geology of the Himalayas*, revised edition, 1934). The crystalline zones of Nanda Devi, Almora, and Kangchenjunga are all autochthonous (their roots go down deep on the spot).

he was thus able to apply the nappe theory, first conceived in the Alps. L. von Lóczy must be regarded as the actual creator of the nappe theory in the Himalayas (Fig. 2). His cross-sections through Kangchenjunga, showing the great recumbent folds, can be compared favourably with those of Argand through the Valaisan Alps in 1912.

In 1893, R. D. Oldham recognized for the first time the overthrusting of the foothills of the Himalayas over the northern rim of the Ganges Plain.

Up to the outbreak of the Second World War, the book written by Burrard and Hayden and published in 1934, *The Geology of the Himalayas*, was the standard work on Himalayan geology. From a stratigraphical point of view, this book had a firm working basis at its disposal by the pioneering work of Hayden in Spiti. The fossil zone there has in the meantime acquired world renown by reason of the richness of the deposits and their very thorough exploitation. In fact there is scarcely another place on earth which has furnished an almost unbroken series of petrifacts ranging from the most ancient primitive times, such as the Cambrian era, up to the Cretaceous era. Nevertheless the geological map produced by Burrard and Hayden to a scale of 1:3,168,000 showed Nepal and Bhutan and large areas of the Indian Himalayas as blank. The tectonic interpreta-

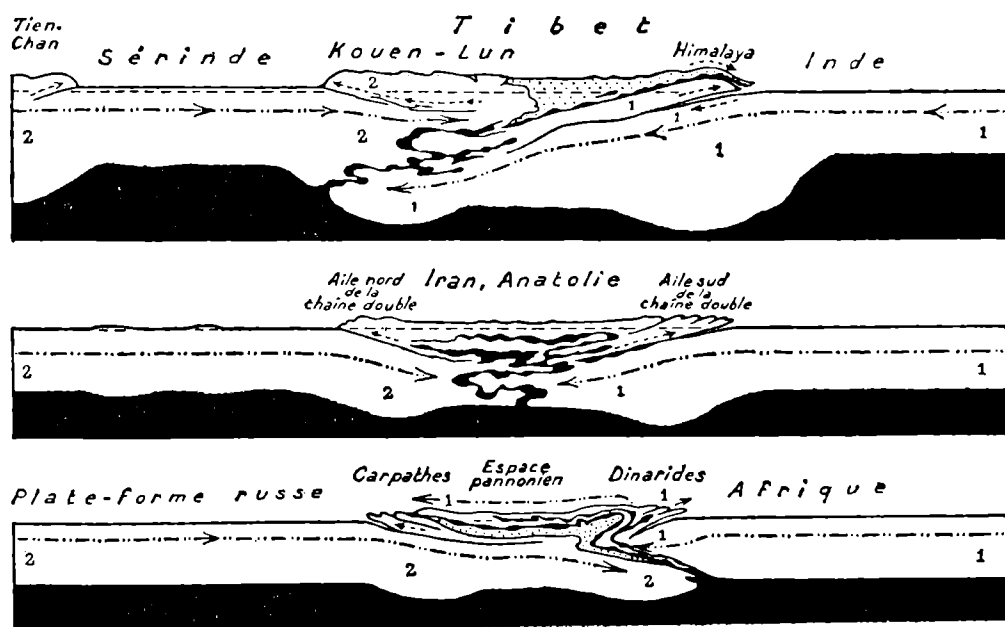


FIG. 4. Tectonic Interpretation of the Himalayas by Emil Argand, 1922.

- | | |
|--------------------------------|------------------------------|
| 1. Indian Subcontinental block | Dotted: Geosyncline contents |
| 2. Asiatic continental block | Black: Sima |

Argand was far ahead of his time with this ingenious theory.

tion included in Burrard and Hayden's work did not tie up with the modern conception of overthrust structure although the nappe theory in the Alps was established at the beginning of this century (Fig. 3). It is evident that Argand's interpretation of the Himalayas in 1922, showing overthrust structure, was purposely overlooked. For at that time, 1934, non-Alpine geologists almost always regarded the nappe theory as 'pure fantasy'.

Up to the present day there is no other work which gives a better elucidation of the tectonic structure of Asia than the admirably contrived *Tectonique de l'Asie* by Emil Argand. Moreover, Argand played a prominent part in the development of the nappe theory in the Alps.

There have been many researches carried out in the Himalayas since the publication of Burrard and Hayden's work. D. N. Wadia's fine book, *Geology of India*, contains a number of them, and among prominent persons concerned with Himalayan research, may be mentioned, Auden, Gansser, Heim, Pilgrim, Sahni, de Terra, Wadia and West.

The principal participant in Himalayan research is the Geological Survey of India, situated in Calcutta. This magnificently organized institution can look back upon a hundred years of rich scientific work and worthy traditions. In the course of the last few years, however, owing to the enormous development work in India, Indian geologists have had to pay increasing attention to practical geology. This explains why basic research in the economically less important mountain ranges has been somewhat neglected.

The works of J. B. Auden, A. Heim and A. Gansser are of supreme importance in the realm of Himalayan research. The works in question were published almost simultaneously, in 1938 and 1939 and for the first time showed a co-ordinated tectonic structure ranging from the Ganges plain to the great Tibetan plateau. Two main thrust groups, bearing different names, were determined; the Garhwal nappes (Auden, Fig. 5) and the central crystalline zone with the Almora thrust masses (Heim and Gansser), together with the adjacent Krol nappes. Each of these thrust groups, according to the authors, is sub-divided into several nappes. The tectonic sub-division of the great thrust masses had already been assumed by Pilgrim and West to be in the area north-west of the Ganges, where at least four overthrust series of nappes were to be seen.

Auden, Heim and Gansser were all rightly convinced that their thrust masses (Garhwal nappes or Almora thrust mass) had their roots in the 'central crystalline zone' of the main chain. The authors reached this conclusion by means of lithological and petrographical comparisons as well as by the geographical stratification. On page 225 of their work, Heim and Gansser write as follows: 'The synclinal crystalline zones or outliers of

PLATE 3. Namche Bazar, 3880 m., the chief town of the Sherpas of Khumbu. Kwangde, 6187 m., in the background

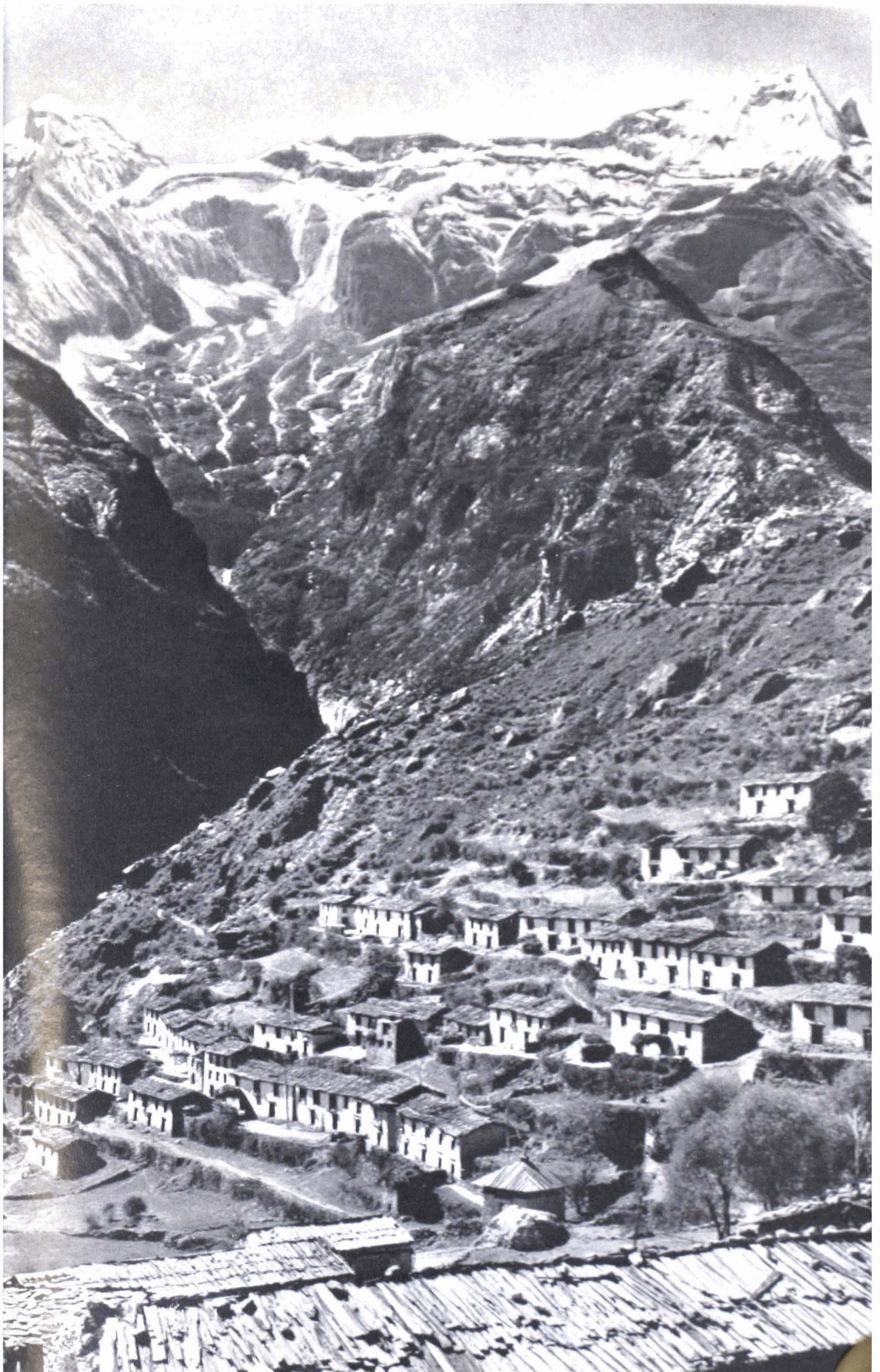




PLATE 4. Interior of Sherpa Sonam's house in Ghaunra kharka. The hearth is the focal point of Sherpa family life. Sonam served C. von Fürer-Haimendorf and Toni Hagen for several years.



PLATE 5. Important service in the temple of Beding (Rolwaling). Rice cakes are heaped up in front of the altar which is lit by small lamps; these rice cakes are afterwards offered up to Buddha. The tubs of *chha* (beer) are communally drunk through bamboo canes and serve to cement friendship.

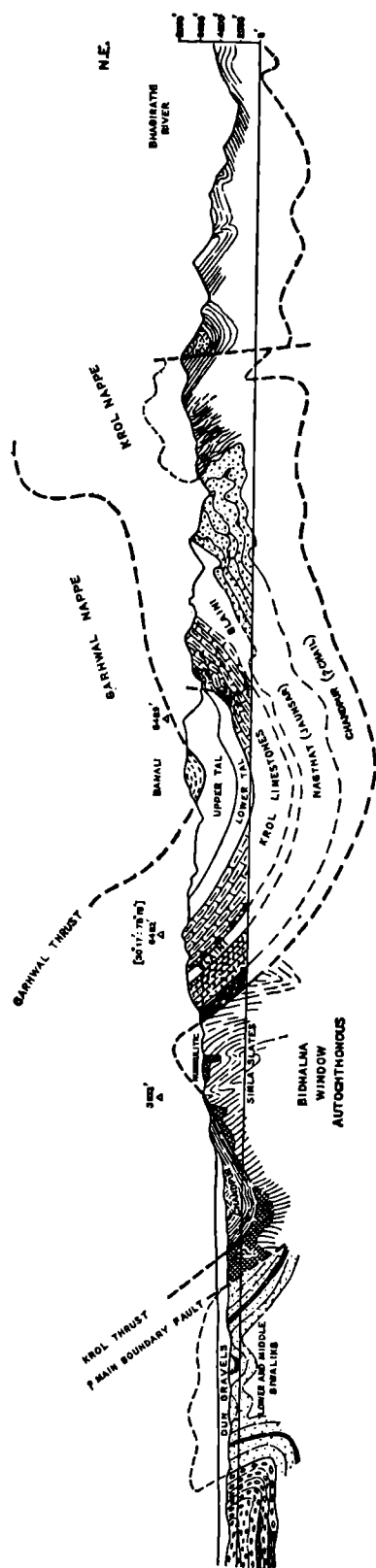


FIG. 5. Geological cross-section across the Siwalik range and the Lower Himalayas, by J. B. Auden, 1938. This is the first cross-section in detail which takes into account the modern theory of overthrust folding.

the lower Himalaya are apparently the prolongation towards SW of this Main Central Thrust Mass. . . . The width of thrusting of the crystalline masses above the sedimentaries visible on the surface, is 95 to 110 kilometres.'

Auden also comes to the conclusion that the thrust masses join up with their root. He expresses himself somewhat cautiously in this matter (Auden 1938, section 3, plate 37): 'It would seem possible that the main Garhwal nappe joins up with the rocks at the base of the Main Himalaya Range and that the minimum distance of translation of this tectonic unit be about 80 kilometres.'

At the time of Heim and Gansser and Auden's works the main root zone which coincided with the main chain, was determined as being between the Sutlej and the Kali Ganga (western frontier of Nepal) in an unbroken line about 300 kilometres long. Heim and Gansser conclude from this as follows (page 237): 'The root is supposed to continue far beyond [the Kali Ganga]. Possibly, even Mount Everest and Kangchenjunga, 800 kilometres east of the Kali Ganga, are the continuation of the same Main Central Thrust mass, which forms the root of the Garhwal nappe.' (Fig. 6.)

Nepal was thus manifestly situated in a transition zone; to the east the great overthrust of Kangchenjunga, with 'inverted middle limb' and to the west the structure of the Krol and Garhwal nappes. A few valuable observations were made in central Nepal by J. B. Auden who, when he was there in 1934, could not observe the 'inverted' series of Darjeeling, but presumably found another lower zone. In the west also, no 'inverted middle limb' is apparent in the cross-sections of the authors. Whereas in the east the crystalline series from Kangchenjunga to Darjeeling (Darjeeling gneiss) run continuously without a break, in the west the actual bridge between the root in the high Himalayas and the overthrust nappes in the south was no longer there, having more or less eroded away. Thus, the actual junction could not be substantiated, although there could be no doubt whatever of its former existence.

A further unsettling factor was that no fossils were discovered in the isolated thrust masses (outliers), as there was a complete lack of normal sedimentary cover. On page 227 of their book, Heim and Gansser state: 'Nothing is left of the normal sedimentary cover of the crystalline Himalaya zones.' This was the situation in which I started my own researches in Nepal in 1950.

I was able to clear up some of the above-mentioned problems during the course of my work. In a number of places I found the real tectonic bridge between the overthrust nappes and the roots, and in the courses of these I discovered some fossils.

While I was working in Nepal (1954), A. Lombard was exploring the south side of the Everest zone. The Frenchman, Abbé Pierre Bordet, paid two visits to Makalu in the Barun Valley, accompanied the second time by M. Latreille. Bordet spent his time dealing mainly with petrographical problems. The results of his labours appeared in a comprehensive geological map of the Makalu area (between Everest and the Arun) and was a work of considerable importance for the geology of the Himalayas (Bordet, P. and Latreille, M., 1958).

At this point I do not propose to discuss in detail the works of either Lombard or Bordet, as I will refer to them later on when I describe the formation of Everest.

5. MY GEOLOGICAL EXPLORATIONS IN THE NEPAL HIMALAYAS

Having made this short dissertation on the theory of mountain-building augmented by some important facts from geological history, let us now revert to the time when I began my own researches.

It is easy to imagine my intense excitement as on a wonderfully clear October day in 1950, I approached the land of my dreams, the still forbidden country of Nepal. I had come alone by rail from Calcutta, and should have met the three other members of the party at Raxaul on the Nepalese frontier but there was nobody there. I crossed the frontier without noticing it as it was not marked at that time and a few hundred yards further on I was stopped by a Gurkha post. They looked at me with great suspicion and took me to the duty sergeant. Conversation was somewhat difficult as none of them understood a word of English. I looked round helplessly and to my great relief saw an old-fashioned telephone in a corner of the simple but scrupulously clean guard room. By dint of signs and with much repetition of the word 'Kathmandu' I finally persuaded the sergeant to ring up Kathmandu and give them my name. At first I had been left standing, but now the sergeant pushed a chair towards me and offered me a cigarette. Servants were summoned and dispatched—all this while the telephone conversation was still going on—until finally a regular hubbub broke out around the person of the intruder who had suddenly turned out to be an exalted foreign guest! Nothing was too good for me, and my every wish was granted even before I had expressed it. I was given my first Nepalese meal, which with its hot spices I found very much to my taste. I was in fine fettle and was well looked after by the friendly Nepalese. It seemed a promising omen for the future. Next morning, my friends having turned up in the meantime, we were received by the representative of the Maharajah and everything went like clockwork. We felt as though we were in an enchanted land.

The great noise of puffing and the output of smoke from the little Sulzer engine seemed to be in inverse ratio to the speed of this train of the Nepalese State Railway, for it took the whole morning to cover the twenty-five miles to the foothills. When we reached the slight gradient just before the first and most southerly hill, two railroad workers got on to the buffers of the engine and industriously strewed sand on the track. As soon as their receptacles were empty, they sprang off, filled up with fresh sand and, chasing the puffing train, jumped on to the buffers again. While all this was going on, a Nepalese official regaled us with excellent hunting stories of tigers, bears, leopards and rhinoceroses. The thick jungle bordering the track lent credence to these descriptions. We crossed the first hills of the Siwalik range by car. In the Suparitar region lying to the north of the Siwaliks, I jumped out of the car on several occasions as we came to the first rock outcrops. The first geological hammer blows in a new country! As we crossed the first pass, the Chisapani Pass, 2100 m., the rock formation changed, and Darjeeling gneiss and granite rapidly followed the quartzite, carboniferous rocks, and slate. It was clear that I had crossed the Krol nappes in the Suparitar region and was now in strata corresponding to the Garhwal nappes.

I shall never forget the view from the Chandragiri Pass (2300 m.) of the valley of Kathmandu spread out before one's eyes like some garden of paradise, with its large towns and temples, framed by the Himalayas red in the glow of the setting sun. I did not become aware of their summits for a few moments, as they appeared almost unbelievably high above the clouds.

I must confess that my first excursions in the heavenly valley of Kathmandu were dedicated to the medieval towns with their rich works of art and the ancient Hindu and Buddhist temples rather than to geology. Nevertheless even while sightseeing I gradually became aware that the Darjeeling gneiss which formed the wide Kathmandu valley exhibited on the whole a synclinal structure (trough). Thus, in the mountains to the south of the valley the strata was generally inclined towards the north and that of the north-lying Sheopuri range, to the south. By reason of my observations of this bedding, I came to the conclusion that it was possible that the next lowest strata, corresponding to the Krol nappes, would reappear to the north of the Sheopuri Lekh in the Valley of the Trisuli and the Tadi Khola (Khola River), particularly as the north slope of the Sheopuri drops from 2400 m. to 700 above sea-level in the Trisuli Valley. My first journey, lasting several days, was made in that direction with Nawakot, a beautifully situated provincial town, as its destination. Crossing the Sheopuri Lekh by the Kokani Pass (2200 m.), I got my first uninterrupted view over the whole foreground right up to the Ganesh-

Himal. This long-distance view removed the last doubts from my mind. The Trisuli Valley contained quite a different type of rock, obviously carboniferous rock and quartzite, as could be seen from the colour and bedding. With increasing excitement I 'hammered' my way down from the Pass to the valley floor. Darjeeling gneiss, mica schist and lime silicate rocks, followed each other in variegated but not yet articulated succession.

Then, suddenly, following upon a garnet mica schist, I found myself standing upon completely non-metamorphic dolomite. This juxtaposition was obviously of a tectonic nature, an overthrust with all the well-known concomitant phenomena. A little further to the north, when wading through the Tadi, I encountered typical 'Verrucano'. The existence of strata of the Krol nappes was thus corroborated. I called this area the Nawakot zone, from the adjacent town of Nawakot. Later on the Nawakot nappes devolved from it.

But proof of the overthrusting of the crystalline zone of Kathmandu was still lacking, for the junction of the Krol nappes of Suparitur with the Nawakot zone below the crystalline massif of Kathmandu, was still purely hypothetical. The interpretation of the Kathmandu massif as an autochthonous crystalline fan still appeared possible. The Japanese petrographers of the Manaslu expedition had long since succumbed to this temptation.

Upon mature consideration I came to the conclusion that it would be quite possible to furnish proof of the overthrust structure of the Kathmandu crystalline zone. On the occasion of my first short journey I observed a general abundant rise of the whole Kathmandu series towards the west. Should this rise continue to the same extent for about fifteen miles it might be possible that the Kathmandu massif would crop out towards the west and consequently the Nawakot zone would actually join up with the corresponding Suparitar zone to the west of the Kathmandu zone.

I soon prepared a plan of campaign for my first long journey; I planned to make a reconnaissance via Nawakot to the north to Rasua Garhi on the Tibetan frontier. There I hoped to find the same rocks as those in the Kathmandu crystalline zone, which would form the root of the conjectured Kathmandu nappes. There were good grounds for these hopes, for I had already observed from the Sheopuri Lekh, a definite anticlinal structure, a great arch of the Nawakot zone. The crystalline zone lying above the Nawakot zone and still preserved at Kathmandu, must surely be encountered somewhere further to the north.

My patience was sorely tried as the preparations for my journey ran into difficulties owing to the revolution which had broken out in the

meantime. No government official would take the responsibility of allowing me to start out in such uncertain conditions.

The Maharajah had placed at our disposal a rather fearsome and heavily armed guard of Gurkhas for our protection. In fact he did his best to make our enforced sojourn as pleasant as possible. Servants kept bringing us delicious gifts of game with his personal good wishes and this at a time when his centuries-old dynasty was at stake.

Finally one day a delegation from the government appeared at our guest house looking very apologetic. In an extremely polite but complicated oriental manner they expressed their regret about the political conditions. We gradually became aware that this was in effect a sort of farewell visit, for the Maharajah took it for granted that in the prevailing circumstances we would wish to return to Switzerland. You can imagine their pleased surprise when we made it quite clear that nothing was further from our thoughts; we had no desire to leave Nepal and the only thing worrying us was the interference with our freedom of movement. I hinted that as a geologist I should be allowed to go out into the field, as otherwise my government would recall me. I was prepared to take full responsibility, for anyhow the revolution appeared to be more of a palace one than anything else. A week later—the middle of January—my most ardent wish had come true and I was on my way to the north via Nawakot.

This was my first important expedition in the Himalayas, but owing to the time of year I was not able to penetrate into the high mountain regions. However, I hoped that the deeply cut gorge of the Trisuli River, which breaks through the main chain at Rasua Garhi, would afford me as instructive an insight into the structure of the mountains as I was likely to get by climbing them.

My caravan included about fifty porters and the equipment was both cumbersome and luxurious; quite unsuitable for my methods of work. The Maharajah left nothing undone to make my journey as comfortable as possible. I was obliged to cart around expensive porcelain crockery and the extra bath tent and a very comfortable commode were his ideas of what was necessary to conform to normal English colonial standards! The result of all this was that my party was extremely top-heavy and porters and servants were all jumbled up together. The caravan was in the charge of a Gurkha Army N.C.O.; the cook was from the Maharajah's guest house, and porters had been recruited from the official coolie agents in Kathmandu. They all, however, had one thing in common, they were very faithful and wished to do their best for their 'Sahib', quite irrespective of their different castes. Caste plays an important part in Nepal. The cook from the guest house was not used to washing up dishes, for at the guest house he had plenty of menials under him for this 'low caste job'.

He detailed one of the porters to do this work and probably paid him with my own cigarettes. The porter was very pleased with his promotion and, full of zeal and devotion, cleaned my personal crockery and the cooking utensils with cow dung! He probably chose this unorthodox material not only on account of its cleaning propensities, but because cow dung—from holy cows of course—was regarded as a medicinal panacea.

Having dealt with the lighter side of my first large expedition in the Nepal Himalayas, let us return to the geological situation as I found it, starting from the lovely little town of Nawakot.

After passing through the huge but rather monotonous quartzites of the Nawakot zone, I traversed conglomerates and dolomite south of Syabru Bensi and found myself on fine gneiss in the narrow gorge. It was the lowest bed of an enormous crystalline zone, the northern edge of which extended beyond the Tibetan frontier at Rasua Garhi. I stood deep in thought at the frontier for a long time and looked with longing at the forbidden land in front of me. Nothing would have pleased me more than to have gone over the boundary to the Tibetan sedimentary zone. However, I had made the important discovery that the main chain of the Himalayas in this sector consisted of the same rocks as those of Kathmandu. It would have been fine to have been able to establish the actual junction in the field, as Heim and Gansser did in the west.

According to my observations there were good reasons for this assumption, for while marching through the Trisuli Valley I had perceived a very acute gradient of the Nawakot zone to the north-east. Thus it seemed within the bounds of possibility that further to the east, on the ridge joining Sheopuri Lekh and the Gosainkund mountains, the crystalline zones of Kathmandu and the high Himalayas were actually united by means of a tectonic bridge. For the time being I was not able to explore this area, for I was working much more to the south and west and was thus unable to follow the junction of the Nawakot zone and the crystalline zone in the Lantang, round the Kathmandu massif to the west. My assumption was, however, justified. In actual fact the Kathmandu massif crops out fifty kilometres to the west of the capital and the quartzite, shales, and carbonate rocks of the Nawakot and Suparitar zones join up without a break. Thus the Kathmandu zone changed into the Kathmandu nappes and evidence of the overthrust structure in the Nepal Himalayas was conclusive (February 1951). A year and a half later the tectonic bridge on the Gosainkund was determined, for without leaving the crystalline zone it was possible to march from the Kathmandu nappes to their root in the Lantang. The results of my first expedition are shown in a cross-section (Fig. 7).

My expeditions had a great advantage over others in that I was not

obliged to limit myself to a few unconnected cross-sections. The breaking off of only a few cross-sections invariably gives rise to great uncertainty. Enormous variations in the direction of strike occur, e.g. with regard to the depth of certain strata. If the geologist is unlucky, he may encounter a cross-section in which some layers of strata are missing or where local anomalies occur due to transversal interference. Generalizations, even when based on such an isolated survey, can only result in wrong conclusions. In the case of a slightly superficial survey the geologist finds it possible to control his hypothesis in the field at the dominant points. I refer in this respect to the example of the already mentioned (page 24) overthrusting of the Kathmandu nappes over the Nawakot nappes in the Trisuli Valley, to the north of Kathmandu. The dolomite encountered on my first trip was only a few metres thick and the 'Verrucano' was practically discovered by chance while wading the stream. I was not a little surprised while systematically searching for the junction of the Nawakot nappes with the Suparitar zone, to find that the dolomite only a few kilometres west of the first outcrop (i.e. in the direction of strike) had risen to more than 1000 m.

I was even more surprised when later on, only two kilometres east of the previous outcrop and also in the direction of strike, I found after much searching only a few decimetres of tectonic dolomite. Thus, a geologist who only went on the last-mentioned trip would in all probability overlook the overthrust between the Kathmandu and the Nawakot nappes. In this case he would not find it necessary to assume such a fundamental separation, but would accept the Nawakot phyllites as a natural sequence to the mica schists at the base of the Kathmandu zone and at the best would define it as an 'inverted series'. This is probably the reason why the Japanese geologists regarded the Kathmandu crystalline zone as autochthonous with fan-shaped structure at the edges.

When I resumed my activities in Nepal in 1952 I had suitable equipment from Switzerland at my disposal and was able to leave all superfluous gear behind. By means of drastic economies I was able to reduce the number of porters to ten in all. Later on I always had the same porters—all relations from two villages—and on one occasion I had five brothers in my team.

Before long I was on very good terms with these men and forged them into a well-disciplined and mobile group, with a correspondingly fine team spirit. Whereas on my first expeditions at least fifty per cent of my energy and time was expended in encouraging the porters and establishing camps, etc., with not much left for geology, with my subsequent team I was able to devote all my time to scientific purposes. The day ran like clockwork and often enough I was the one who was driven. With

research work of this kind, I consider it absolutely essential that a regular daily programme should be regarded as inflexible, almost sacred in fact. In such cases when the body is strained to the limit, one cannot afford the luxury of a free untrammelled decision. My men had the strictest instructions to break camp a quarter of an hour before sunrise every day and this included my own tent. How often would I have liked to stay in my warm sleeping bag, especially in the rather grim cold high mountain camps. But my tent was ruthlessly torn down over my head and I had no choice but to get dressed and start on my way. In a quarter of an hour at the latest the camp was packed up and the porters ready to march off. In the evening, after seven or eight hours' march, the process was repeated in reverse. Half an hour after the camp site had been fixed, all tents were up, a fire was burning brightly, and water was on the boil. Five minutes later, a cup of steaming hot tea would be on my table. I had no need to bother myself with all this activity and usually dozed off on my chaise-longue (setting up which was always the first task) thus husbanding my strength for the night's work of writing up my field book and drawing cross-sections.

Owing to the small number of porters it was impossible to take any tinned foods with us and our diet consisted of local products obtainable in the villages, such as maize, barley, rice, millet, or eggs.

Two of the ten loads carried consisted entirely of drugs and medicines, for apart from the porters I had to care for the local population who regarded all white men as 'Doctor Sahibs'. Our journeys into the far-away parts of east and west Nepal kept me away from civilization for as long as six months. Thus, among other arrangements, I had to devise my own postal system and employed two Sherpas as post runners. Frequently it took them up to five weeks on foot from my camp in the Himalayas to the nearest post office in Kathmandu or India.

Over the years I developed a special technique of geological research. Using Kathmandu as a centre, I systematically set out to the east and west. In order to obtain a complete picture of the geological structure, I made my journeys in a north to south or south to north direction wherever possible, i.e. at right-angles to the so-called geological direction of strike. Comparing this with the Alps, it would never occur to a geologist to make his first exploratory journey from Chur up the Valley of the Vorderrhein and down the Rhône Valley to Geneva; he would on the contrary march from north to south.

There was no difficulty in picking the desired route in the thickly wooded country of central Nepal. I marched almost exclusively along the ridges, partly because it was here that the best outcrops were to be found and partly because the ridges afforded a good view to both sides.

When in the high mountains, however, I was of necessity forced to abandon the ridges and make my way through the tremendous gorges leading north to the Tibetan frontier. Whenever possible I endeavoured to use the same route only once and when close to the frontier always tried to get from one transverse valley to the next. These crossings were mostly high glacier passes and frequently caused me and particularly the porters no end of difficulty. However, I did not regret them in the slightest, for apart from the magnificent beauty of the high mountains, these high passes provided some of the greatest adventures of my trips.

My method of work consisted in running around with my hammer during the march and examining the rocks—hammering sections in geological jargon—and noting the results in my field book. The rocks were roughly examined macroscopically and if limestone was suspected, tested with hydrochloric acid for lime content. Rock samples were collected from any important-looking outcrops. As and when I discovered any strata and structures, I inserted them in the 1:250,000 topographical map of the Survey of India—the existing geological map of Nepal. I sketched panoramas and took photographs from all good view-points. I was able without much difficulty to insert geological data into the panorama sketches as well as into the geological map on the basis of the previous cross-sections, for I had a detailed survey of the neighbouring ridges at my disposal. On the farther side, which was ‘new’ geological terrain, geological data was subject to extrapolation. Nevertheless, prominent geological strata, e.g. hard quartzite beds or soft mica schists, could be followed from the site over the valley to the next ridge. When I examined the ridge on my next trip, employing extrapolated geology, the work mainly consisted in verification of the previously assumed extrapolated conditions. At the same time extrapolations were made from the ridge on the side of the ‘new’ geological terrain. Thus, each of my surveys was on the one hand a verification or correction of the terrain lying between the present and the previous routes and on the other hand an extrapolation on the side of the ‘new’ geological terrain. By this method of systematic survey, it was possible to obtain fairly complete superficial cover.

The lateral interval between the separate route surveys varied with atmospheric visibility, outcrops and the complications of geology. From April to June, when visibility in central Nepal is limited to a few kilometres owing to summer haze, the cross-sections have to be very close together in order to produce satisfactory results. On the Tibetan plateau, on the other hand, where limestone formations can be discerned from distances of over fifty kilometres, only comparatively few cross-sections are necessary.

Conditions along the route must also be taken into consideration. In the Terrai, covered with primeval forest, and particularly in the Siwalik, it is not possible to move far away from the tracks. The same may be said of the very steep forest-covered southern slopes of the Himalayas.

In order to cope with these factors, I chose an interval of approximately fifteen to twenty-five kilometres between the single route surveys. Moreover, I confined my activities to the haze-free high mountains from April to June, and later on I suspended work in the field altogether during these unfavourable months. The best time for scientific work in the Himalayas is in the spring in the mountains and in the winter in the plains.

Already in 1950 in the course of my first expedition in central Nepal I became aware of the existence of considerable overthrusting. I progressed systematically from west to east and was thus able to add rock after rock to the geological mosaic.

I append herewith a few of the most important dates of discoveries in chronological order.

In January 1951 the tectonic window of Pokhara was recognized from the air. In May 1952 the first index fossils were found in the Annapurna massif. The cross-section shown in Fig. 8 (1954) shows the discordant contact of the Manaslu granite with the Tibetan sediments and the subdivision within the Kathmandu and Nawakot nappes. In the summer of 1954 the great sedimentary basin of Langu (north of Dhaulagiri) was discovered and mapped. The sliced structure of practically the whole country became unquestionably clear to me after only a few trips. By surveying large areas, the actual junction of the overthrust massifs with their roots was determined over wide tracts. This overthrust structure had, however, one important defect; no fossils of any consequence were found there. The corresponding geological zone outside Nepal (Garwhal and Sikkim) has long been inscribed in scientific literature as 'an unfossiliferous zone'. Since 1956, however, this expression can be struck out, for at Phulchok, a few kilometres south of Kathmandu, trilobites of the upper cambrian-silurian system were found in the Kathmandu nappes.

The reader may perhaps be of the opinion that too much space has been devoted to explorations outside the Everest massif. My rejoinder to this is that any investigation limited solely to the circumscribed Everest area would lack sufficient proof of its formation. The most important geological discoveries were all made outside the actual area of the Everest massif. This is partly explained by purely geographical reasons: the north side of Everest lies in forbidden Tibet, whereas further to the west the kingdom of Nepal extends far over the main chain to the geologically important sedimentary zones of Tibet.

6. CALM BEFORE THE STORM IN THE FORMER HIMALAYAN SEA

Let us return in spirit to the era of 60 million years ago, i.e. at the end of mesozoic system (the geological middle ages). At that period the great Himalayan Sea spread out over the area of the central Himalayas of modern times; this was the so-called Tethys, with the Himalayan geosyncline (Figs. 9 and 10). To the north and south the Himalayan Sea was hemmed in by the old continents of the continental blocks. The bed of this great marine basin was filled with thick sediment, deposited during the 180 million years or so of the mesozoic period.

Below these mesozoic sediments lay the deposits of the palaeozoic era, also extremely extensive. It is possible to form a conclusion from the extent of these sedimentary deposits in the Himalayan geosyncline, if one bears in mind that geologists assume the following maximum figures of sedimentation:

Tertiary	(60 million years)	22 kilometres
Mesozoic	(180 million years)	26 kilometres
Palaeozoic	(300 million years)	60 kilometres

Naturally these maximal thicknesses were never attained at any one single spot, for there was scarcely a single place during the whole of these periods of time which was continuously covered by the sea and thus subjected to sedimentation. It must, however, be accepted that the sediments in the Himalayan geosyncline attained a thickness of many kilometres.

These thick sedimentary deposits possibly covered old mountain structures in the synclinal trough. Nevertheless extensive remains of former mountain formations on both sides of the Himalayan geosyncline are still preserved today. For example, the Aravalli range in North India is the oldest mountain range on earth, about 1200 million years old (Fig. 9). Its sediments were deposited more than 1200 million years ago. It has been found that this oldest mountain range had been repeatedly rejuvenated in later mountain formations. There is no other possible explanation that anything has remained at all after such a long period of erosion, and not only as a peneplain (levelling off of mountains by erosion), but in the form of mountain ranges. The Aravalli system extends beyond the mountains visible today into the Vindhyan peneplain to the north-east.

Without doubt the Aravalli range was formerly much more extensive and at that time stretched from the Indian Deccan right over the present-day Himalayas and probably into the Tibetan zone. In fact the Aravalli chain runs in a straight line at right-angles to the main Himalayan range. This can be plainly seen on a flight from Bombay over the magnificent

structure of the Aravalli range. The limited remains visible today of the Aravalli range should not, however, detract from the fact that the Aravalli zone with its structure running from south-west to north-east, formerly included large areas of the oldest part of the Himalayan geosyncline. This plausible assumption was later corroborated in the Himalayas, as we shall see. In 1952 in the great sedimentary basin of Mustang and Muktinath, north of Dhaulagiri and Annapurna, I found a great

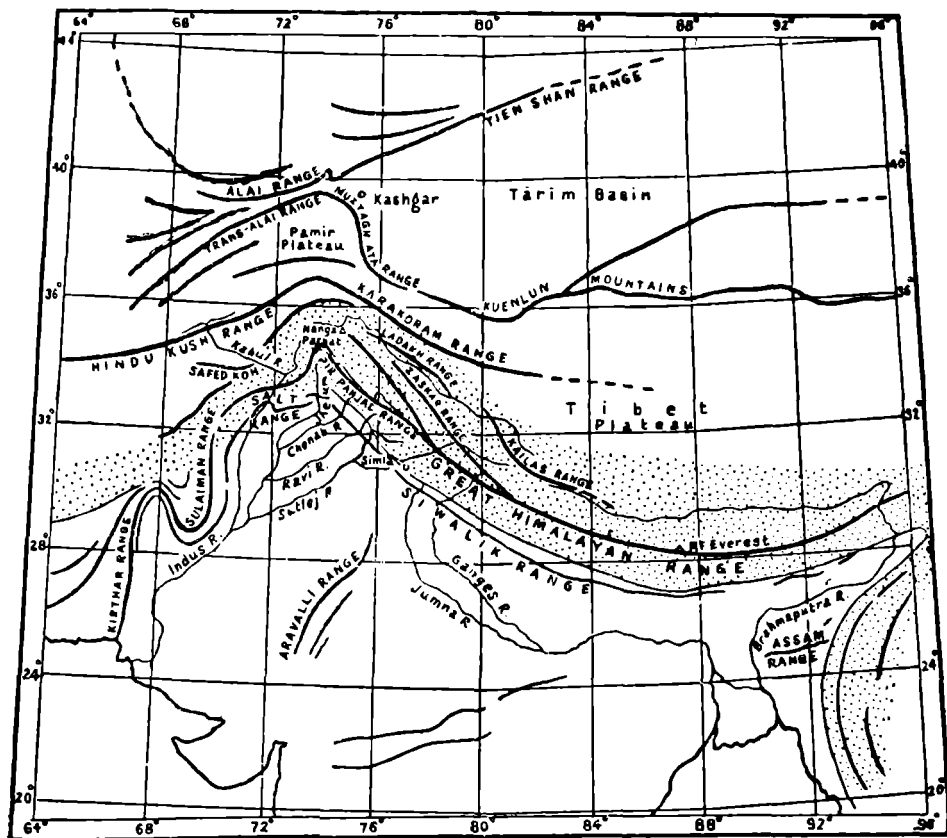


FIG. 9. The Himalayan geosyncline and its relationship to the adjoining mountain system (Burrard and Mushketov, 1934).

transversal rift structure (the Thakkhola *graben*), running through the Kali Valley between Annapurna and Dhaulagiri. A second attempt to make a further study of this geologically important terrain failed in 1954 owing to various misadventures and serious illness. However, I finally reached my goal in the autumn of 1957. I discovered a transversal fault containing fossils, along which the western complex was so considerably uplifted (about 2000 m.) that beds of the silurian were lying alongside cretaceous *flysch*. The latter percolated through from the cretaceous down to the

silurian further north in the fault area. From this can be deduced the existence of a spit of land or even a bridge which must have lain right across the Tethys (sea) during the earlier part of the mesozoic era. It would be purely hypothetical to try to back-date this prominent transversal to Aravalli times. But its pre-alpine age (at least variscan period) is definitely proved.

Up to now this is the only case of a cross-fault where the age could be confirmed by fossils. There are numerous other transversal faults in the Himalayas which must be considered as pre-orogenic, i.e. before the formation of mountains. A not unimportant fault of this type ran through the bed of the Tethys and the southern part of the Asiatic continental block on the meridian of the Arun Valley of the present day. Other, less important, transversal faults ran in a south-west to north-east direction through the terrain of the present Bhote Kosi, the Dudh Kosi (Namche Bazar), Nangpa La, and through Everest itself.

Transversal faults of this type are always points of weakness, even though they are not large ones and do not display visible vertical displacements or cross-thrusting. Nevertheless they all played an important role later on during the formation of Mount Everest.

In comparison with the following tertiary era, the mesozoic period was one of relative calm, which took effect after the greatest event in the

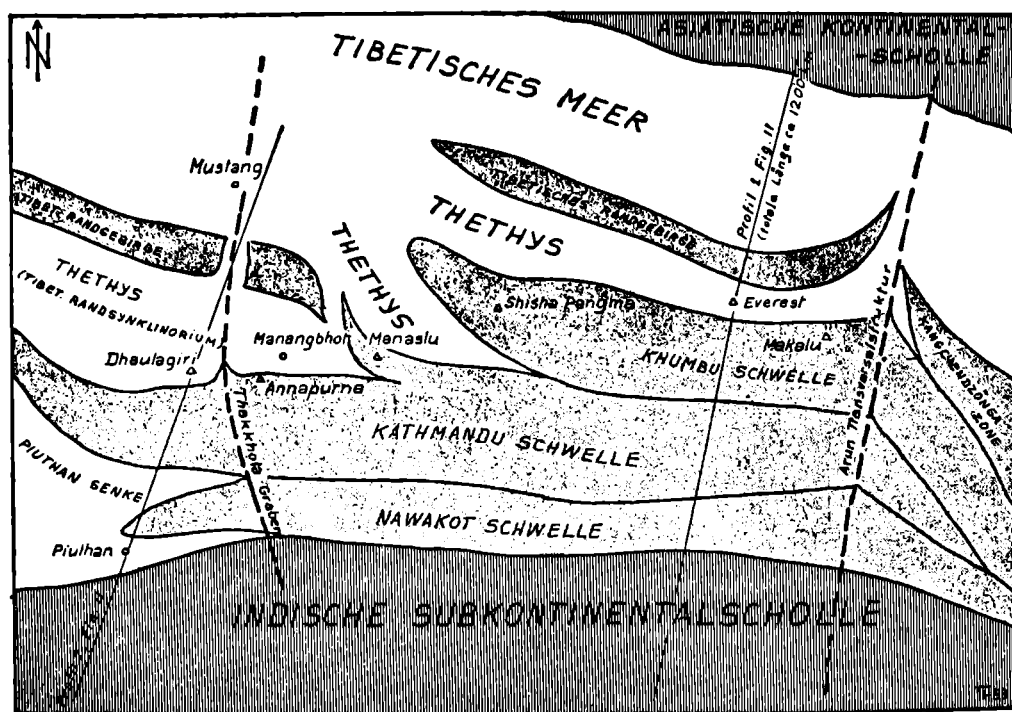


FIG. 10. Reconstruction of the Himalayan geosyncline in central Nepal.

PLATE 6. Ama Dablam, 6856 m., the lordly guardian above the Monastery of Thyangboche

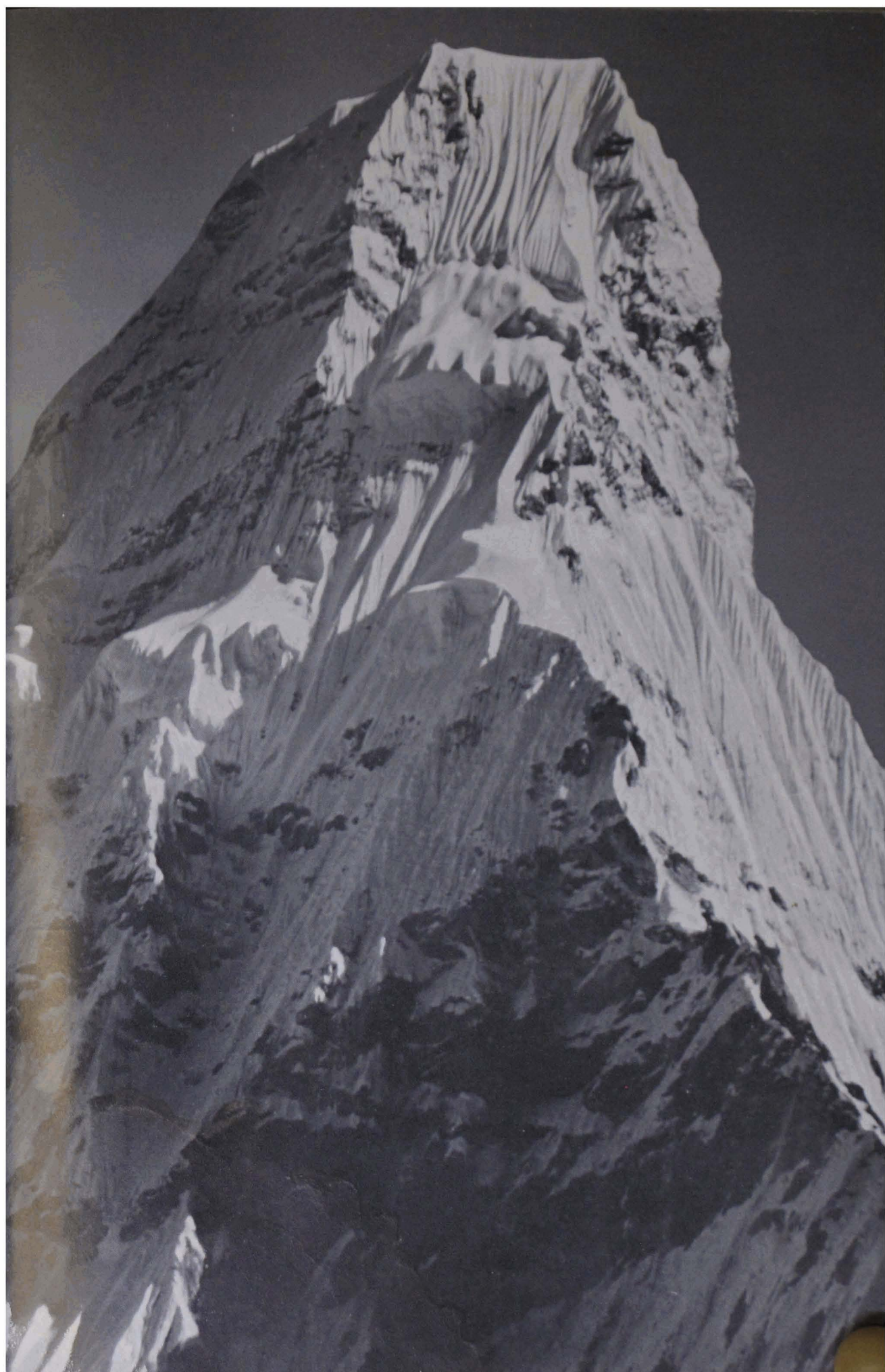




PLATE 7. The Khumbu Glacier from the south. To the right is the pyramid of Pumori, 7145 m.

history of this part of the earth, namely the break up of the Gondwana continent after the carboniferous era about 270 million years ago. The old Gondwana continent included the present-day Indian sub-continent, South Africa and Australia. It has been proved that certain changes in the geosynclines had taken place even in the mesozoic era before the beginning of the actual formation of the mountain ranges. The fairly frequent occurrences of layers of conglomerate rocks and breccias in almost all tectonic zones and in almost all mesozoic strata discovered to date, support this. The 'Verrucano' of Nawakot, the polygenetic trias breccia of Delunga and the chalk breccia of Muktinath (all in Nepal), can only have been deposited close to elevations in the bed of the Tethys or at the sides of rising ground (Fig. 10). At all events the tectonic movements of the alpine geomorphic cycle, even if only relatively unimportant faults or arching, may be traced back to eras before the actual formation of the mountains. Opposed to the older, pre-alpine mountain formation, they lie in the same direction of strike as the later Himalayas. In the Alps these occurrences have been to some extent accurately fixed by stratigraphical research. So accurate in fact that the pre-orogenic events in the geosynclines appear so complicated that it is not immediately possible to reconcile them with former theories of a simpler nature.

Just as in the Alps, the pre-orogenic movement in the Himalayas does not only work in one direction. Uplifts and depressions, trench and horst formations follow each other in quick succession. Undulations on the floor of the Tethys Sea were temporarily raised and their erosion detritus deposited on the shores. Later on these ridges sank back again into the sea and the fresh marine deposits increased, leaving behind a so-called gap in the strata above considerable series. It was possible to determine this in the Nepal Himalayas by observation of the transgression of upper chalk and eocene formations on what were probably cambrian and trias schists in the Piuthan zone.

The Himalayan geosyncline was therefore not just a simple glacial trough before the actual formation of the mountains. It must have looked very much as shown in Figs. 9 and 10. After the trias era the Nawakot uplands appeared above the sea from time to time, and the post-triassic strata were absent.

Later, at the time of the cretaceous-eocene era, a more narrow marine inlet was formed between the Nawakot uplands and the Indian block—the Ganges Sea. The Nawakot uplands did not assume an unequivocal position, for up to the time of the cretaceous era they appear to have formed part of the northern edge of the old Indian continent. We do not, however, know what lies hidden today below the kilometre-thick alluvium of the Ganges trough. At the southern edge of the Ganges plain, opposite

Nepal, there is no evidence of post-carboniferous sediment, and to the north the Kathmandu and Nawakot uplands join up at an acute angle. These can hardly have been covered at all by the sea, for there is no trace whatever of carboniferous strata (Figs. 10 and 11).

It is not possible to determine whether the pre-mesozoic beds were originally present or not; they may well have been there but were removed by erosion after the formation of the mountains.

Towards the west, in the widening gap between the Nawakot and Kathmandu uplands, a depression was formed at the time of the upper cretaceous and eocene eras, in which the subsequent Piuthan zone was deposited. The Kumbusch uplands join on to the northern end of the Kathmandu uplands again at an acute angle. This also appears to have stood out above the Himalayan Sea during the whole of the mesozoic era. A marine inlet of the Tethys extended between the converging Kathmandu and Kumbusch uplands (Fig. 10). This inlet joined up with the main part of the Tethys to the north-west of the Kumbusch uplands.

The northern boundary of the Tethys was formed by the Tibetan highland rim. North of this the great Tibetan Sea extended to the actual southern edge of the Asiatic continent existing at that time and sediments similar to those found in the Tethys were deposited there.

Before the actual formation of the mountains—exactly how long cannot be determined with precision—fusion took place in the lower layers of the earth's crust. This fusion was partly directed through predestined pre-orogenic zones of weakness, but the complete fusion did not reach the surface everywhere. There were zones above the actual bulk of the homogeneous granite in which the old sediments were saturated by magmatic substances. This resulted in a metamorphosis of the old sediments (quartzite, sandstone, schists) to gneiss, mica schists, and mixed rocks (migmatites).

Old gneiss, formed from sediments in much older geological eras, were also affected by the new metamorphosis. It is difficult today to differentiate between the individual phases of metamorphosis; at all events these metamorphic formations are now the rocks which largely form the basis of the Everest group. This accounts for the presence of fossils on the south side of the Everest massif.

It is assumed that these intrusions and metamorphoses in the formation of the subsequent strata, before the actual formation of the mountains, took place at anything up to thirty kilometres below the surface of the earth.

The see-saw movements, if one can call them such, were presumably not caused by reciprocal overthrusting of the Asiatic and Indian continental blocks. It was more in the nature of small, vertically directed ad-

justing movements, which remained limited to the weakest zone between the rigid inflexible continental blocks. It was the calm before the storm, which before long would change the face of this part of the earth.

7. THE FIRST MOUNTAIN RISES OUT OF THE HIMALAYAN SEA

The first storm broke out during the cretaceous era, about 70 million years ago. At that time the Asiatic continent was again in a phase of retreat from the Pole. In the course of its journey towards the south it

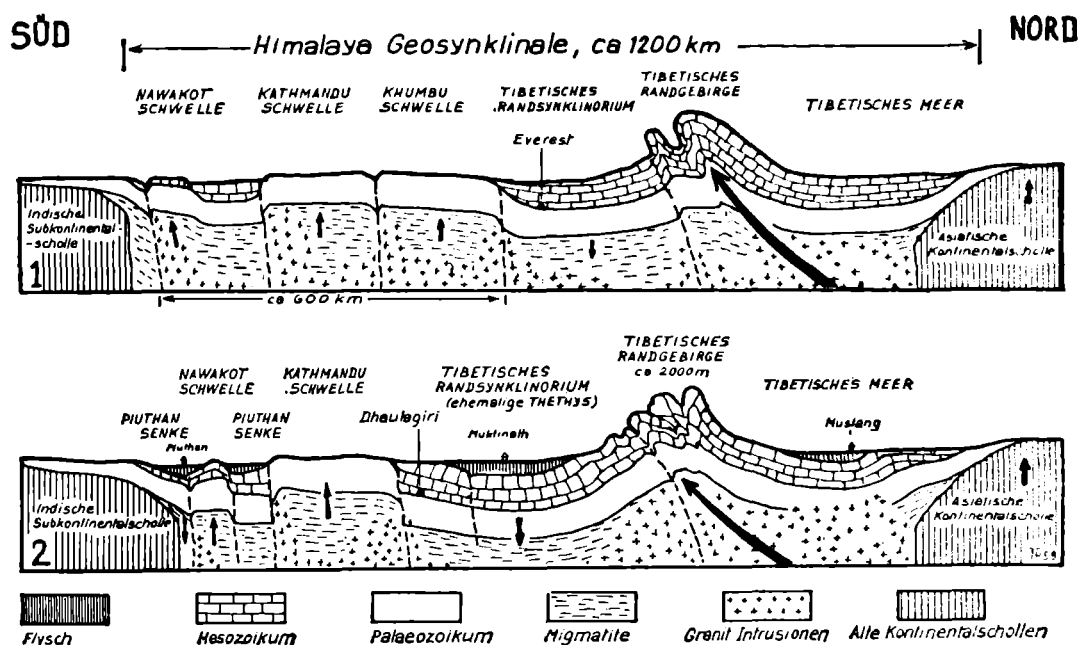


FIG. 11. Schematic representation of the Thorung stage of mountain formation in the upper mesozoic era. *Section 1.* Cross-section of Mount Everest. *Section 2.* Cross-section of Dhaulagiri (approximately five-fold exaggeration of vertical scale).

came into violent contact with the Tethys Sea. This being the weakest zone in this longitude, could not withstand the pressure as the great bulk of the Indian continent prevented an escape to the south. The already mentioned pre-orogenic faults, fractures and uplands of the time immediately preceding served as excellent zones of weakness, along which the contents of the geosyncline attempted to escape.

When the deep, weak, geosynclinal zone became crushed between the two approaching continental blocks of Asia and India, the central part of the geosyncline, the Tibetan uplands at the edge, were the first to be

affected. They were folded over in a very complicated manner and raised as the first mountains. They possibly reached a height of from 1500 to 2000 m. (Fig. 11).

Simultaneously, with the convergence of the continental blocks, a slight uplift of the most northerly part took place. Emil Argand made reference to this uplift in his sketch of 1922 (Fig. 4). The relatively higher position of the north edge of the synclinal trough tipped the folds towards the south (as opposed to the direction of the Alps). We may call this first stage of mountain-building the Thorung stage, after the Thorung range near Muktinath in north Nepal.

The narrow marine depression between the Nawakot uplands and the Indian sub-continent was widened, forming the Ganges Sea, as it may be referred to from now on. The uplands also disappeared under the sea towards the west and the thick carboniferous and schist formations were deposited in the ensuing Piuthan depression. The northern part of the Piuthan Sea disappeared again during the eocene era.

Although the mountain formation of the Thorung stage was only on a moderate scale compared with the subsequent towering up of the Himalayas, it nevertheless had a permanent effect on the future Himalayan range; for it created the primeval outline of the present-day remarkable river system. The Tibetan highland rim, as we may call the mountain chain formed from the Tibetan marginal uplands during the Thorung stage, became the first watershed, in fact the main watershed between the developing Ganges and Tsangpo-Brahmaputra River systems. From here the rivers flowed north to the Tibetan depression and above all to the south. The Tibetan highland rim was broken through by the eroding rivers. In the Thakkhola transverse fault, north of Annapurna, the astonishing discovery was made that the *flysch* from cretaceous and older tertiary eras had been partially deposited in old valleys.

8. NATURE IN THE RAW

In preparation for the second phase of mountain-building, magmatic flow and fusion from the interior of the earth occurred. Large blocks of granite were formed and partially melted the old rock strata as far as the silurian. Dikes, particularly pegmatite, extended to upper regions, gradually 'dying out' as they approached the surface. But unlike the earlier magmatic penetrations, the pegmatites penetrated right through the strata and through earlier layers of migmatites, ortho-gneiss, and granite. From this fact we are able to account for the two different stages. The second magmatic action must have taken place at some time in the lower oligocene era, roughly before and during the Nawakot stage. The Everest

massif today shows extensive traces of the intrusion of the second stage, an example of this being the granites and pegmatites on Nuptse.

Geologists assume that the stages of mountain-building are irreversible. Folds, for example, were not smoothed out any more, but at the same time were not subjected to re-folding at a later date. Rock formations which had been subjected to tectonic deformation (folding) were rendered rigid by this process: they reacted to subsequent forces with tectonic fracture (faults, similar to the hardening of metals caused by mechanical deformation).

We will now see how the operation of the law of irreversibility is demonstrated on many occasions in the terrain under investigation. The uplifted Tibetan highland rim in the Thorung stage was shown to be rigid compared to the new stage of mountain formation. When the continental blocks approached each other and squeezed the geosynclines between them, the Nawakot zone was the weakest spot. From here the Nawakot nappes were overthrust to the south for a horizontal distance of up to sixty kilometres (Fig. 12, Sec. 1). This stage—the Nawakot—was probably in the lower miocene era, about 10–15 million years ago.

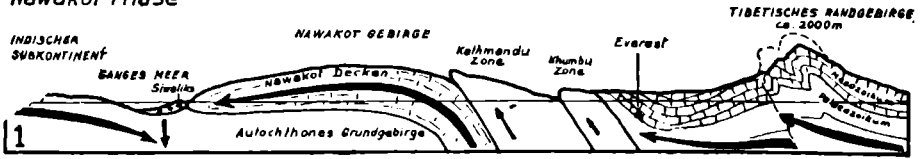
The second stage of mountain-building, the Kathmandu stage, must have occurred about 7–10 million years ago, in the upper miocene era. It became the principal stage, for first the Kathmandu nappes and shortly after the Khumbu nappes (at least seven nappes in all) were uplifted from their respective zones by enormous forces and thrust far to the south over the already existing Nawakot nappes. The distance of overthrust of the Kathmandu nappes from the roots to the nappe front attained about eighty kilometres, in the cross-section of Everest. The distance of overthrust of the Khumbu nappes in the same meridian was considerably less, about twenty-five kilometres.

New structural changes occurred in this main stage: the old pre-alpine cross structures were reactivated. The impact of the Asiatic continent was so violent that its edge, bordering the zones of weakness of the old cross structure, split up into isolated blocks (Fig. 15). These blocks remained rigid in themselves, but 'rubbed' against each other, resulting in new vertical and transverse movements, which pulverized the rocks at the points of juncture.

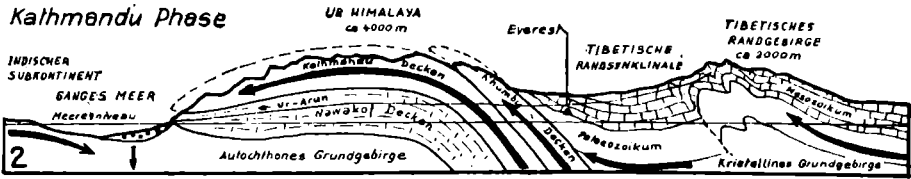
The reactivation of the old transverse faults, combined with pulverization of the rocks, was naturally not only limited to the Tibetan zone, for the already overthrust nappes were also involved.

We have already seen how the approximately 2000-m. high Tibetan highland rim became the watershed before the Nawakot and Kathmandu nappes formed the original Himalayas of probably 4000 m. altitude. Simultaneously with the formation of the latter range the earliest rivers

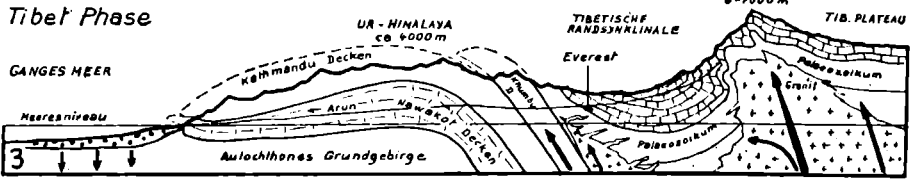
SSW
Nawakot Phase



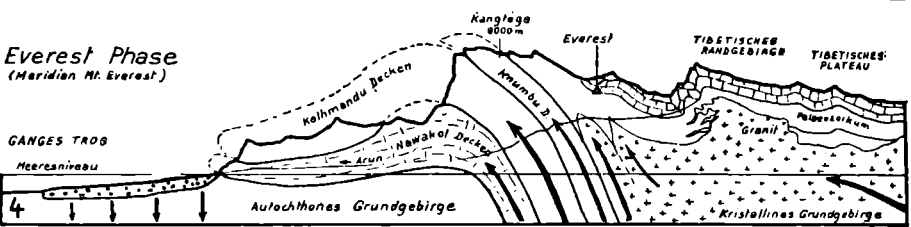
Kathmandu Phase



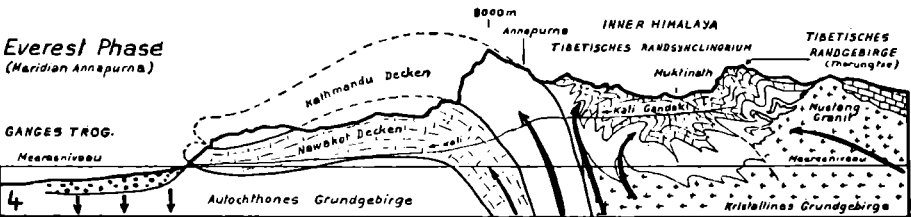
Tibet Phase



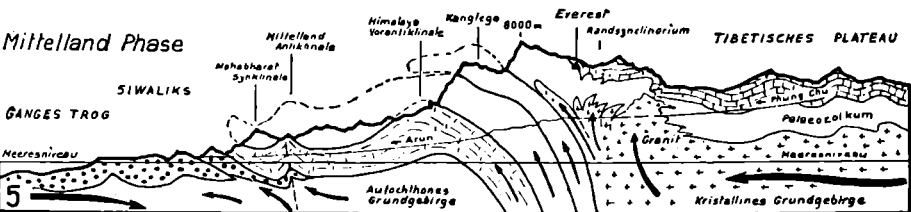
Everest Phase
(Meridian Mt. Everest)



Everest Phase
(Meridian Annapurna)



Mittelland Phase



Mahabharat Phase

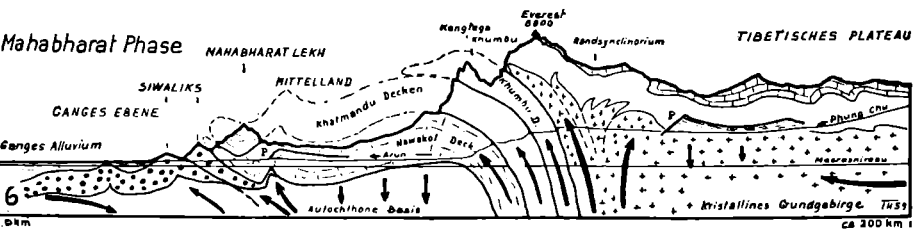


FIG. 12. Formation of the Everest massif. Attempt at a schematic representation in six stages, as follows

1. *Nawakot Stage* (Miocene). Convergence of the Asiatic and Indian continental block compression of the Himalayan geosyncline—simultaneous weak uplift as compared to the Indian sub-continent—squeezing out and overthrust of the Nawakot nappes from the join between the Himalayan geosyncline and the Indian sub-continent. Start of the uplift of the Kathmandu and Khumbu zones.

2. *Kathmandu Stage* (Middle to upper miocene). Overthrust of the Kathmandu and Khumbu nappes over the Nawakot nappes—sinking of the Ganges Sea (foredeep)—deposition of erosion detritus in the northern part of the Ganges Sea (Siwaliks). Deepening of the original water system along old transversal disturbances (Arun).

3. *Tibetan Stage* (Old pleistocene). Uplift of the Tibetan plateau together with the marginal mountains to their full height of approximately 4000 m.—sinking of the Ganges trough—increased erosion and deposition of detritus forming the Upper Siwaliks in the Ganges Sea—granite intrusions in the Tibetan marginal mountains (Mustang) and in the most northern nappe roots (Nuptse).

4. *Everest Stage* (Longitude of Mount Everest). Increased horizontal thrusting forces—involved squeezing together of the nappe roots and upward thrusting to 8000 m.—slicing over the nappe roots (Makalu, Nuptse and Everest *Schuppen*)—vigorous erosion of the sediment contents of the marginal synclines owing to upthrust—formation of the characteristic knickpoint of the rivers on breaking through the nappe roots—the High Himalayas form the climatic division—increased erosion on the southern side—arid climate in the north—the main chain progresses to the north.

4. *Everest Stage* (Longitude of Annapurna). Increased horizontal thrusting forces—involved squeezing together of the nappe roots and upwards thrusting to 8000 m.—slicing over the nappe roots with evidence of backwards folding—squeezing together of the Tibetan marginal synclines to form the complicated marginal synclinorium—formation of the characteristic knickpoint in the flow of the Kali Gandaki in the nappe roots between Annapurna and Dhaulagiri. The High Himalayas form main climatic division—increased erosion on the southern side—the watershed moves farther to the north—tectonic impounded lakes found to the north of the rising roots.

5. *Mittelland Stage*. Predominance once again of converging horizontal forces—folding and flexures in the autochthonous basement complex with overthrust nappes—formation of Himalayan pre-anticlines, Mittelland anticlines and Mahabharat synclines—slicing of nappe heads over the Siwaliks and the northern Siwaliks—folding of the Siwaliks in the piedmont—deepening of the Ganges trough (by some kilometres), filling in with pleistocene detritus—breaking up of the Arun transversal anticlines, erosion in the weakened Arun Valley attacks the Tibetan plateau, folding on the Tibetan plateau.

6. *Mahabharat Stage*. Sinking of the whole high mountain massif as compared with the hinterland and the piedmont—raising of the Mahabharat Chain to 3000 m., formation of the Mittelland—back-tilted valleys—('Alpine marginal lakes') e.g. the Kathmandu Valley—backward inclined valley terraces and pleistocene lake deposits in the Kathmandu Valley (P)—sinking of the massif on the north side exceeded by further rising of the roots—pleistocene strata rises up to the Himalayan Chain in the south (P)—main crest with the highest summits moves further north owing to erosion; in the Everest stage from the Kathmandu nappes over the Khumbu nappes—relative uplift still continues today—continuation of crust movements in the Siwalik zone and in the Ganges trough—main watershed between Ganges and Tsangpo moves northwards—continuation of erosion from the south along the Arun transversal structure into the Tibetan plateau.

rising far in the north in the Tibetan marginal mountains, cut into the primitive Himalayas. They were thus following the already mentioned zones of weakness of the old transverse structures. They became transverse rivers, which are such a feature of the Himalayas.

Thus, the present-day lower courses of the ancient rivers of the Arun, Dudh Kosi and the Bhote Kosi, rose in the terrain of the Everest group which is the subject of our investigation (Fig. 22).

The rivers on the south side of the Himalayas brought down large quantities of detritus to the foot of the mountains. It was deposited on the northern edge of the Ganges Sea as Siwalik formation.

The Siwaliks correspond in every respect to the molasse along the edge of the Alps. They give to some extent a portrayal of the events which took place in the catchment areas of the rivers in the mountainous hinterland. The red-brown schists and marls of the lower Siwaliks are attributed to the miocene era, while the lighter coloured sandstones of the central Siwaliks are of the upper miocene era. The latter indicate a mineral content, which clearly points to the uplifted, and now exposed, crystalline formations of the Kathmandu and Khumbu nappes in the hinterland. There were grains and small crystals of quartz, felspar, biotite, muscovite, and turmaline, to mention only the most important. Frequently the rocks bore a marked resemblance to the so-called 'Appenzell granite' of the Swiss molasse.

The severity of the erosion during the period from the middle to the end of the upper miocene era, can be deduced from the great thickness of the central Siwaliks, extending to a depth of several kilometres. The Kathmandu phase must date from this time. Between the primitive Himalayas and the Tibetan marginal mountains extended the shallow trough of the Tibetan marginal syncline (Fig. 12, Sec. 2). Its sediments at this time were fairly well folded owing to earlier rift formation.

The Tibetan marginal synclinorium must have been very dry at that time, for there are no equivalent deposits similar to the Siwalik deposits in the south. Rudimentary tertiary deposits are only to be found in local troughs of a tectonic nature, such as in the Thakkhola fault north of Annapurna. On the other hand the sub-equality of the summit level points to a peneplanation, which obviously took place very early on.

9. THE UPLIFT OF THE TIBETAN PLATEAU

At the beginning of the pleistocene era (about 600,000 years ago) great events completely changed the face of the primitive Himalayas. The whole Tibetan zone was raised up out of the Tibetan Sea.

This enormous uplift of some 4000 m. meant as a result that the Tibetan

highland rim, about 2000 m. in altitude, now attained the 7000-m. level and thus considerably surpassed the Himalayas of that day.

A decisive climatic change also took place. The highland rim held off the southerly rain-bearing winds and the high plateau became a mountain desert. The curtailed rivers north of the watershed sought an outlet and eventually found it after a long detour to the east and west. This fact explains the remarkable course of the Indus and Tsangpo-Brahmaputra.

In conjunction with the completely different climate and the differing amounts of precipitation between the north and south sides of the water-

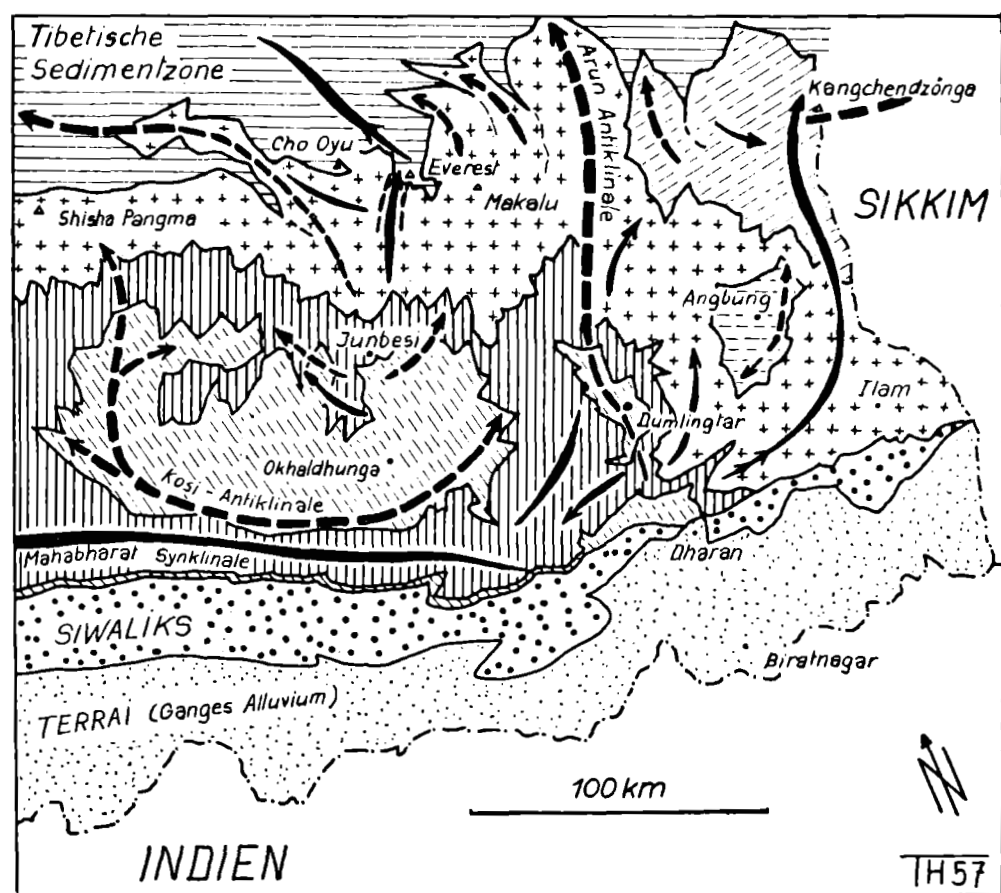


Fig. 13. Tectonic sketch-map of East Nepal by Toni Hagen.

shed, there was also a great difference in the amount of erosion. The much more severe erosion on the south side was further increased by the enormous difference between the gradients of the river courses. The rivers flowing south had a gradient of more than 6000 m. over a course of a little over 100 kilometres horizontal distance, whereas they had to cover thousands of kilometres to the north before they reached sea-level.

When referring to the raising of the Tibetan plateau, mention must be made of great granite intrusions, which characterize this zone. There are in particular two zones which undoubtedly played a part in the formation of the Tibetan highland rim. Considerable difficulty, however, is encountered in trying to fix a date. Where they appear in the great granite massif of Mustang and the granite zone of Mugu, they are probably of the tertiary era. They show completely irregular fusion contacts with the mesozoic sediments. The pegmatic spurs of the granite massif of Mustang running off to the south follow the bedding planes throughout. In the case of the Mugu granite, however, the problem is greater, as the undoubted tertiary granite massif joins up with the crystalline zone of the Kathmandu nappes without a break or any visible variation.

To the south of Mustang coarse granite detritus was discovered on pleistocene terraces! The origin of this detritus is definitely in the north, i.e. in the Mustang granites, for the detritus increases in depth and size as one proceeds in a northerly direction. The deeper pleistocene and the tertiary deposits are completely free from this granite detritus. The possibility of this detritus belonging to the pleistocene era can by no means be excluded, but on the other hand exception can be taken to this in that the granite massif was first of all covered in the pleistocene era and then gradually laid bare by erosion.

It must be stated, however, in spite of the query as to date, that a part of the Tibetan granite intrusions is connected with the uplift of the Tibetan plateau. Somewhere between the Tibetan marginal synclinorium and the southern edge of the plateau there must have been planes of movement, which evidently were not without influence upon the course of the granites.

These planes of movement moreover did not always run parallel to the direction of the geological strike, but cut obliquely into the marginal synclinorium in places. This resulted in the curious overlapping between the Tibetan highland rim and the root zone of the nappes. The most northerly of these split off from the actual root zone and disappeared in the Tibetan plateau as a simple crystalline anticline (Figs. 13 and 18). This is plainly to be seen in the Everest region. It might be deduced therefrom that the identification of tectonic structures for hundreds of kilometres along the direction of strike, as has been the custom in the Alps in recent

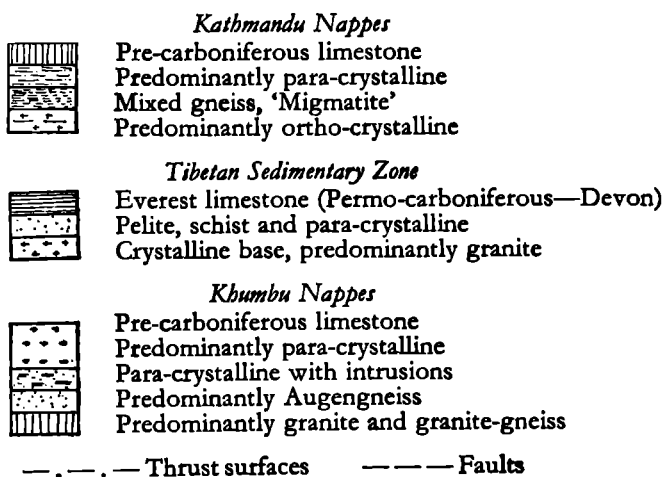
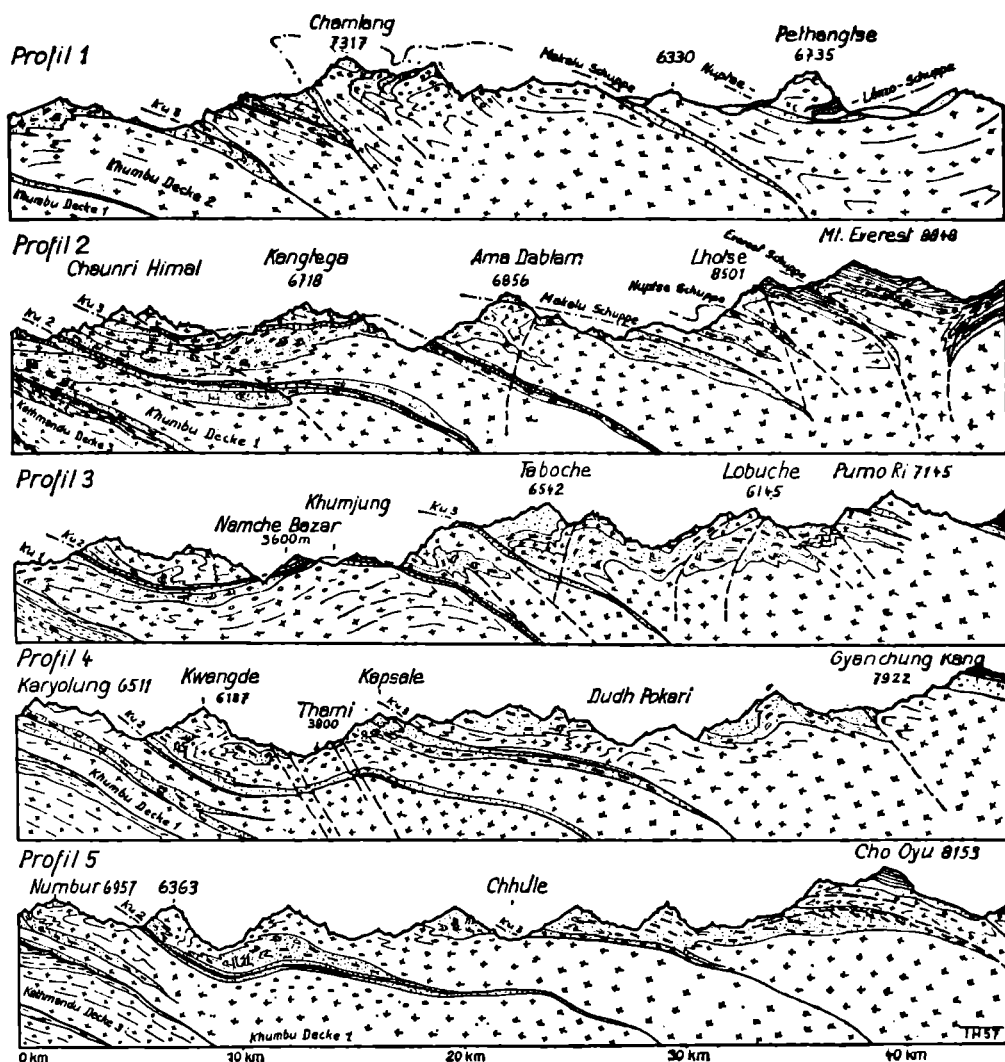


FIG. 14. Five geological profiles through Mount Everest, by Toni Hagen.

years, is very uncertain (despite the absence of any relevant examples in the root zone).

10. THE HIGHEST MOUNTAIN IN THE WORLD—FOR LESS THAN HALF A MILLION YEARS

During the raising of the Tibetan plateau (from the upper pliocene to the middle pleistocene eras) fresh forces were unleashed in a final clash between the Asiatic block and the Indian sub-continent. It was as though these forces intended raising up a new nappe series on top of the already existing Kathmandu and Khumbu nappes. For some reason or other it did not come to pass and the nappe formation remained in the initial phase. The zone adjoining the roots of the Khumbu nappes to the north were therefore sliced (*verschuppt*) (Fig. 12, Sec. 4). At the rear of the Khumbu nappes were formed the Sakyatang, Makalu, and Nuptse-Chomo Lonzo Schuppen and, finally, the Everest Schuppe (Figs. 14 and 19).

Along the already mentioned transverse structures in which were formed the pre-alpine courses of the ancient Arun, the ancient Dudh Kosi, and the ancient Bhote Kosi, the plateau disintegrated into separate blocks (Fig. 15). In contra-distinction to the overthrusting in the miocene-pliocene eras, when the Asiatic block acted as a mechanical unit, the southern edge of the present Tibetan plateau was not able to withstand this last impact and split up into isolated units.

These isolated blocks had their own dynamics. Although the main direction of shock of the separate parts was towards the south and south-west, they became mutually involved. The old transverse structures were, for the last time, strongly reactive. Most of them were raised up to form

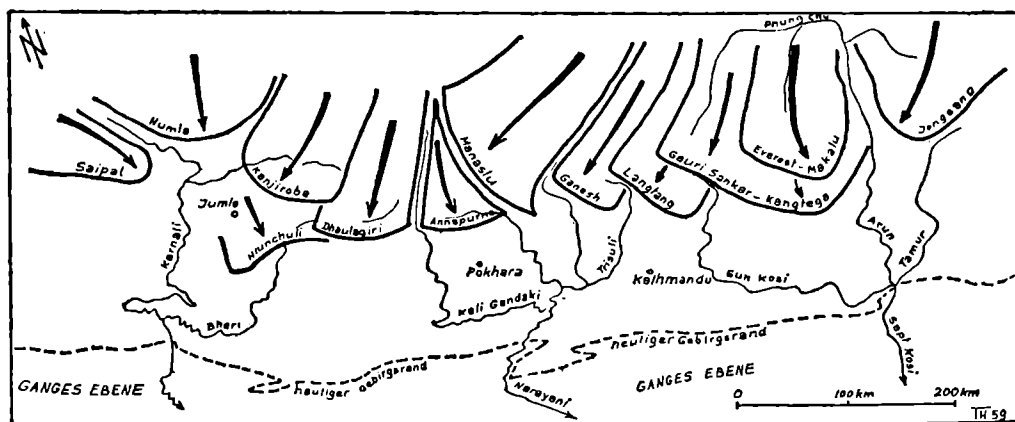


FIG. 15. Graphic representation of the separate thrust arcs and their relationship to the subsequent river systems.

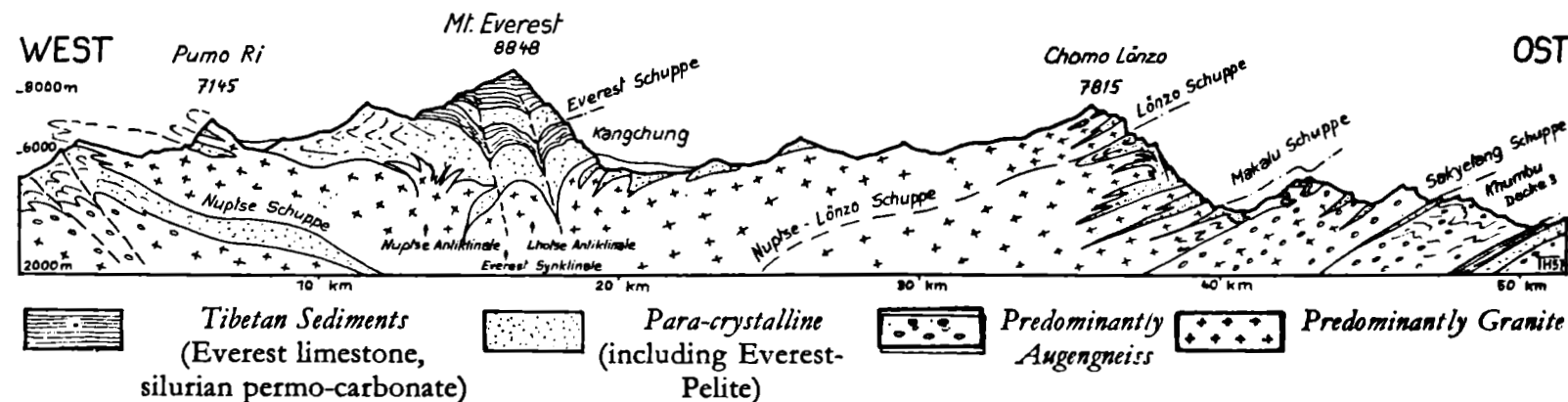
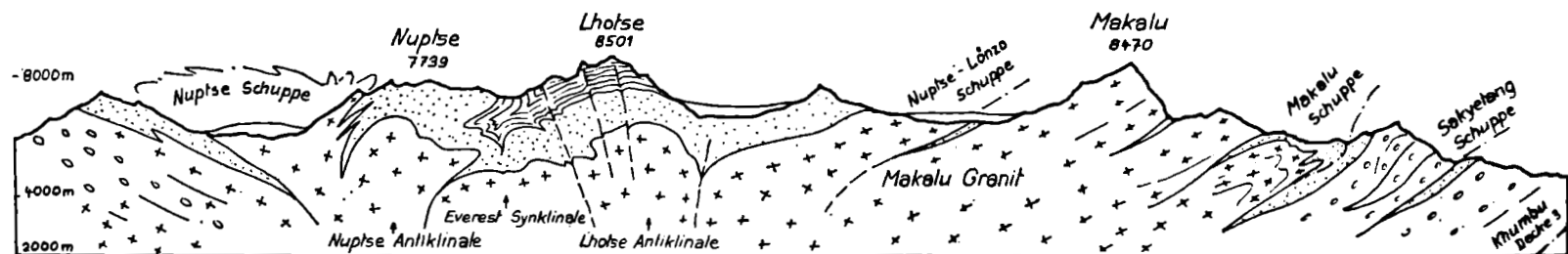


FIG. 16. Two geological longitudinal profiles through the Everest group (East to West). Contrary to expectation, these profiles show the pronounced synclinal stratification of Mount Everest.

anticlines or even steeply inclined anticlinal fractures. All the great transverse valleys in the Nepal Himalayas possess an anticlinal structure of this type. The greatest and most impressive of these runs through the Arun Valley from north to south. Owing to the presence of these transverse anticlines, the nappe roots were arranged in separate tectonic curves which were looped together like festoons (Fig. 17). It is thus shown that the nappes are older than the last reactivation of the transverse structures, otherwise they would not have been involved by them.

At the same time, however, the nappe roots were not interrupted by the cross-faulting, but continued over them in widely extending curves to the north. The roots of the Khumbu nappes, for example, extend in the Arun Valley up to twenty kilometres to the north around the Arun anticline (Figs. 13 and 18).

In contrast, however, to the nappes the youngest Schuppen lying on the back of the Khumbu nappe No. 3, do not continue over the Arun anticline. It would be tempting to assume from this that they were not formed until after the cross-faulting. However, fine frontal curves in the direction of the anticlinal axis on both sides of the Arun anticline (on the east face of Chomo Lonzo and on Makalu (Fig. 16)) prove that these Schuppen were missing above the Arun Valley. P. Bordet writes that in the Arun Valley, at least fifteen kilometres crystalline has been eroded away at the vertex of the Arun anticline. This hypothesis, however, is untenable, as the upper crystalline Schuppen were never present at all.

Based on this analysis, we can place the date of the raising up of the Arun anticline, i.e. the reactivation of the old corresponding transverse structure, as the period between the formation of the backwardly inclined Schuppen north of the nappe roots (Himalaya marginal Schuppen) and the ensuing uplift of the nappe roots themselves. It appears that the thrusting force which led to the arching came from the east, corresponding to the previous mutual proximity of the tectonic root curves progressively moving towards the east.

We have now perhaps found the reason why there was no uniform nappe formation in this last phase in spite of the great tangential forces released: the edge of the Asiatic block would undoubtedly develop a considerably greater thrusting force as it was a solid block, a dynamic unit. After the splitting up into isolated blocks a greater part of the energy involved was absorbed by lateral actions, e.g. upthrust of the Arun anticlines. The process may be likened to a group of ten men armed with spears. Well disciplined, acting as a united body, they develop an immeasurably greater force of impact than if each one separately elbowed his way forward so that the forward impetus was not a synchronous action.

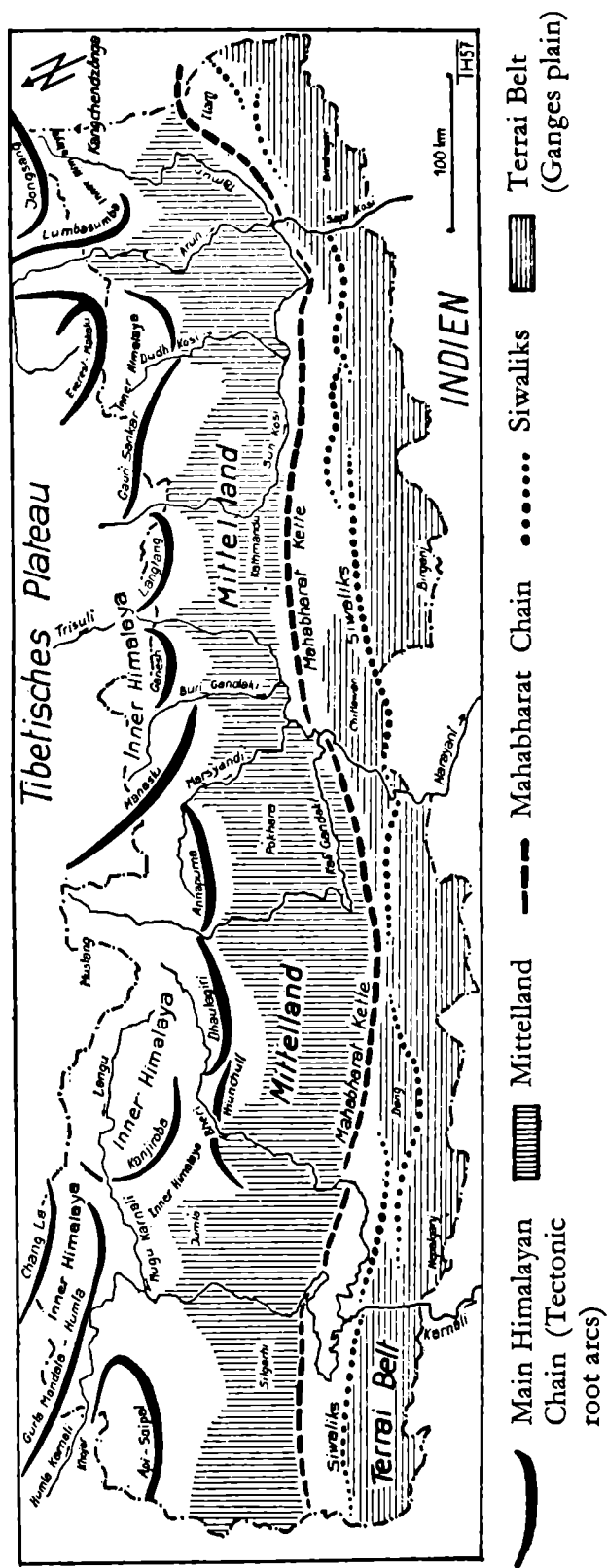


FIG. 17. The natural configuration of Nepal and the arrangement of the tectonic root arcs.

Up to now, in the course of our long story of mountain-building Mount Everest had not yet become the highest mountain. It is in fact open to question whether the Himalayas were the highest mountain range in the world at the time of the final upthrust of the Tibetan plateau. The last great event in the history of the earth was yet to come. It cannot, however, be considered as unrelated to the upthrust of the Tibetan plateau and the formation of layers at the rear of the nappes. While these processes were still going on the roots of the great nappes were steeply graded and squeezed upwards rather like toothpaste out of a tube (Fig. 12, Sec. 4). It was not until the advent of this stage—the Everest stage—that the Himalayas became the highest mountain range in the world. The altitude of Mount Everest consists of a sum total of the 4000 m. of the primitive Himalayas, plus the 4000-m. upthrust of the Tibetan plateau, to which is added another 2000 m. by the upthrust of the roots. The amount of uplift of the roots was probably even greater, possibly over 3000 m.

If all the above figures are added together they give a total of 11,000 m. This discrepancy compared with the actual height of Everest of 'only' about 9000 m. is, however, fictitious, for the various uplifts were accompanied by erosion. It is therefore incorrect to state that Everest was 'formerly' only 11,000 m. in height. This figure of 11,000 m. is only valid if the sum total of the upthrustings is accepted without taking the effect of erosion into consideration—a state of affairs which never happens in nature.

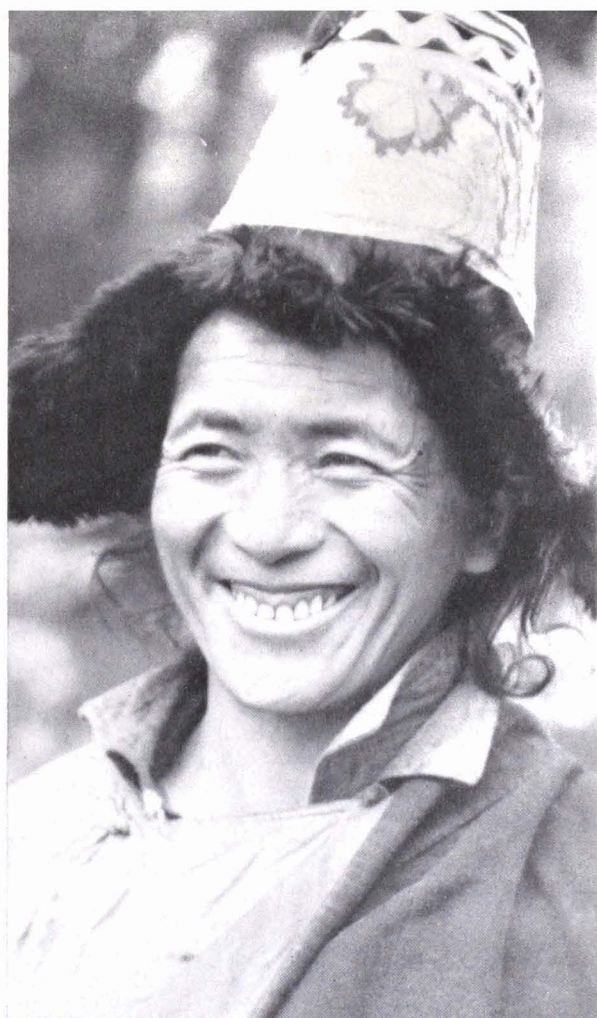
If one considers the general structure emanating from the above-mentioned events, it is quite clear that the stratification of Mount Everest—contrary to all expectation—is synclinal when viewed in longitudinal profile (Fig. 16). The whole Everest range between the Arun Valley and the Nangpa La forms a tectonic sector. It is a syncline which is enclosed between the Arun transverse anticline to the east and the Nangpa La transverse anticline in the west. The fact that the Everest syncline itself is also subject to further complications does nothing to alter the total basic structure in any way.

The conditions obtaining here are descriptive of Everest but they are repeated in all mountain ranges in the Nepal Himalayas. The entire chain is split up into isolated segments by the great transverse valleys, corresponding to the upthrusting tectonic curves, as already described (Figs. 15 and 18). Looked at in longitudinal profile, all these segments are seen to be synclines.

The apparent contradictions expressed by the various authors as regards the geological interpretation of Mount Everest, are at once made clear by the above explanations. Lombard regarded the commanding height of

PLATE 8. The Chorten of Thyangboche, the religious centre of the Khumbu Sherpas. Kangtega, 6178 m., in the background





Everest as an axial culmination. Bordet considered it as an axial depression (1955). In 1953, Lombard first of all talked about *pre-alpine* transverse faulting. According to him, Everest is much higher than all other Himalayan summits because the edge of the Tibetan Plateau in its last stage was raised up to the 'Nuptse anticline', in other words the rim of the plateau was particularly high at this spot owing to the obtrusion of this feature. Bordet, on the other hand, only mentions young, late-alpine cross-faulting, emanating from the great Arun transverse anticline. Both authors are right in their views. One must not, however, exaggerate purely local phenomena, for Lombard's 'Nuptse anticline' was only of local importance (*cf.* Fig. 16). Generally speaking, Everest—seen in longitudinal profile—has a synclinal structure (Fig. 16). Later on, after more thorough elaboration of his calculations (1958), Lombard endorsed this view and recognized the synclinal stratification of Everest. On the other hand, to regard the Everest transverse faulting as a product of late or even post-alpine events, does not apply, in view of the enormous carving out of the Arun Valley with its basically different geological structures on either side of the river. The Arun anticline is a pre-alpine transverse structure, which was reactivated during the formation of the Himalayas.

The tectonic sketch indicated in Fig. 18 shows the main tectonic up-thrust curves. These form at the same time the main mountain groups, separated from one another by the transverse valleys. These, from west to east, are as follows: Saipal, Kanjiroba, Dhaulagiri, Annapurna, Gurkha Himal (Manaslu-Himalchuli), Ganesh Himal, Lantang Himal, Gauri Sankar, Everest-Makalu, Lumbasumba, and Jongsang. The majority of the Nepalese 8000-m. peaks lie on these tectonic root curves. The only exceptions are Shispa Pangma, which owes its commanding height of 8013 m. to an axial culmination in the Tibetan marginal mountains (main watershed), and Kangchenjunga, which lies on an axial culmination of the so-called Himalayan pre-anticline (*cf.* page 57) to the south of the root zone.

It is manifest that these prodigious events in the Himalayas had an effect upon the erosion and subsequent sedimentation, i.e. the Siwaliks. The latter with their miocene fine-grained sandstones formed an abrupt contrast to the coarse conglomerates and rocks, which correspond to the alpine Nagelfluh. The conglomerates of the Upper Siwaliks are attributed to the pliocene and lower-pliocene era.

The conditions of sedimentation may have exerted an influence upon the lithological change in the Siwaliks. In the pliocene era the sedimentation area in the Ganges Sea alternated from marine to brackish, fluvial and even aeolian. The Ganges Sea retreated.

The statement with regard to the Central and Lower Siwaliks, namely that the north side of the Himalayas had nothing to compare with the

PLATE 9. Well-to-do Sherpa woman from Khumjung, wearing hairband; the ear discs and necklace are of beaten gold. PLATE 10. Sherpa from Pangboche, wearing a brocaded hat trimmed with fur. PLATE 11. Sherpa girl from Tharkegyang (Helmu). Sherpa women living outside the Khumbu Valley wear lighter clothing. PLATE 12. Young Khamba woman from Khumjung carrying her child on her back in a shoulder pannier

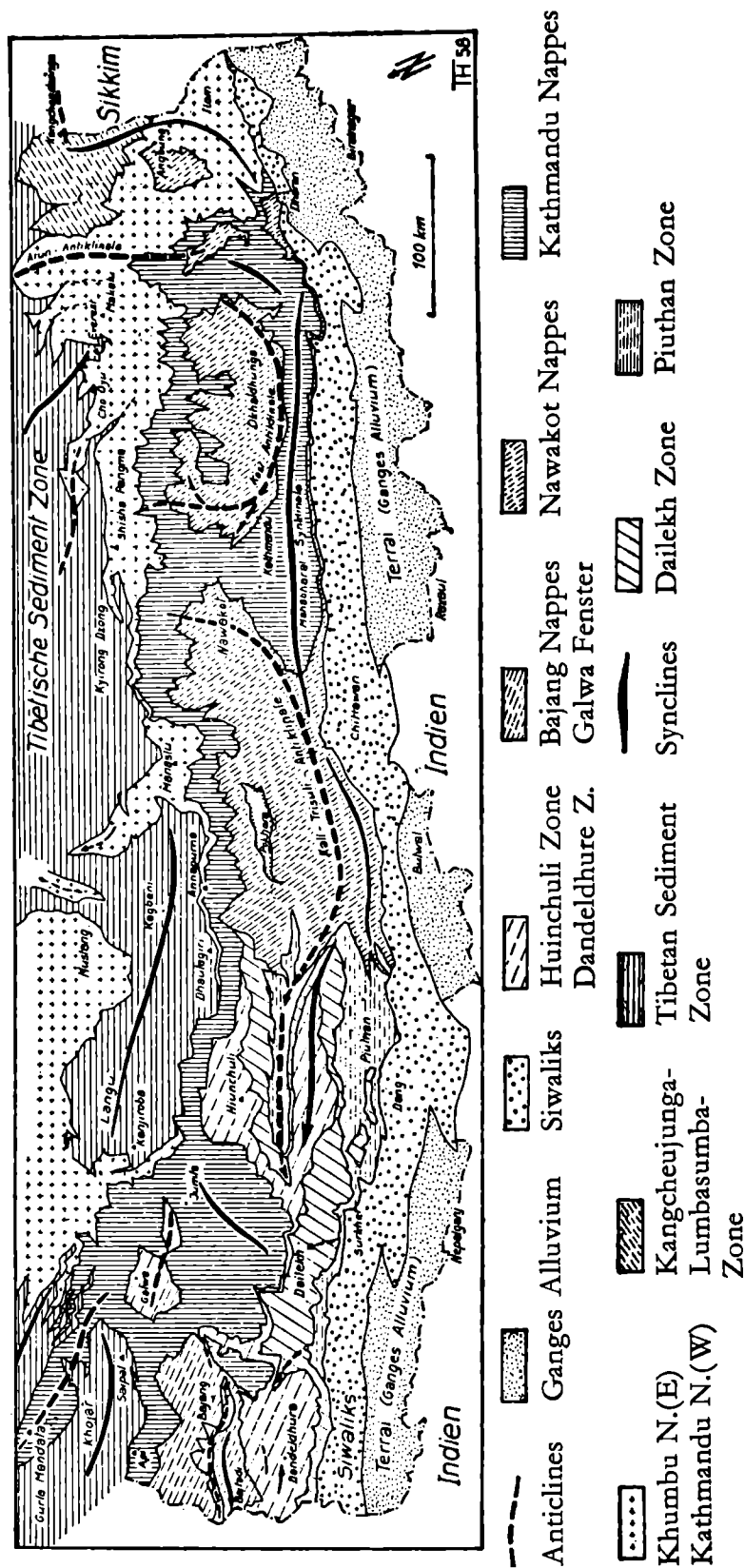


FIG. 18. Tectonic sketch-map of Nepal.

Siwalik formations, is also true of the Upper Siwaliks. One must not, however, conclude from this that no erosion and sedimentation of miocene and pliocene formations took place on the north side of the primeval Himalayas. For I discovered Nagelfluh rock formation—in juxtaposition to Jura limestone—on a summit of about 6000 m. close to the Damodar Pass at the eastern edge of the Muktinath basin, which could be said to correspond to the Upper Siwaliks of the pliocene era. Most of these formations in the area of our research terrain on the north side of the Himalayas, had succumbed to the effects of erosion.

The layman who is accustomed to more mundane standards may be surprised at the title of this section 'The Highest Mountain in the World—for less than Half a Million Years'. 'Millions of years' is an expression which is a little difficult for him to grasp. Also, he may well not be able to reconcile this figure with the opinion of the geologists that the Himalayas is a very young range of mountains.

The geologist on the other hand might consider that in the matter of surprise the boot is on the other foot. We know, for example, that the first men, or at all events their immediate predecessors, the anthropoids, also made their appearance in the pliocene era. Primitive stone tools, such as arrowheads (flints) had been found in the Upper Siwalik deposits.

The primitive races of the pithekanthropus or the sinanthropus, who had already made and used tools, lived in the former pliocene era, that is to say at a period of maximum geological convulsion when the Himalayas were thrust up to their present altitude and as a direct consequence of which radical morphological and climatic transformations took place over large areas.

The naturalist who is used to dealing with much greater chronological scales will contemplate with something akin to horror the conception that the highest mountain range was actually formed before the very eyes of mankind. We are face to face with a tempo of terrestrial development completely foreign to geological primitive history. In point of fact development appears to speed up, similar for example to what we know from palaeontology of animalcules.

A condensed time-scale of the formation of Everest will be found on page 69.

II. ISOLATED POSITION OF KHUMBU, THE HOME OF THE SHERPAS

The structure and morphology of the Everest range evince certain peculiarities and complications which are not present in the other 8000-m. peaks. This is due to a temporal and spatial structure of the stage of the root zone uplift and formation of backwardly inclined Schuppen.

It had already been observed in central Nepal (Fig. 17), particularly on Manaslu and Annapurna, that the separate tectonic pressure curves due to the uplift of the roots did not occur at the same time. The Annapurna curve must be the oldest in the Nepal Himalayas. At a later date the Manaslu curve, subject to considerable angular discordance, joined on to its eastern end (*cf.* Fig. 18). Thus the festoon of curves was formed link by link, generally in a west-east direction. At the longitude of Everest the roots of the Kathmandu nappes now begin to turn off towards the south-east and after a last drift towards the north round the Arun transverse anticline, the Kathmandu nappes terminate at the Siwalik zone a little to the east of the Arun River (Fig. 18).

In this stage, therefore, which saw the build-up of the central Nepal 8000-m. peaks, it was not Everest which was formed but the first high mountain range in front of it including the summits of: Numbur (6957 m.), Karyolung (6511 m.), and Kangtega (6718 m.) (Fig. 12, Sec. 4). The first two lie on the Khumbu nappe 1, the next highest unit to the Kathmandu nappes, corresponding to the backwardly inclined Schuppen of the Kathmandu nappes in central Nepal. At this time this southerly mountain chain was the highest point. In contrast to central Nepal, a second stage is said to be joined on to this stage in the Everest sector. Within a short period of time the Khumbu nappes developed from a crystalline anticline of the Tibetan highland rim (the subsequent Shisha-Pangma anticline). In the terrain of present-day Khumbu the roots of the Kathmandu and Khumbu nappes diverge. While the former, as already mentioned, end at the Siwalik zone east of the Arun, the Khumbu nappes take on the main task of mountain-building from here to the east. In the territory of present-day Khumbu the distance between the Khumbu nappe roots and the Kathmandu nappes was so great that shallow overthrust foldings took place. These are the existing shallow stratified crystalline series inclining to the south in the valley basin of the Khumbu near Namche Bazar (Fig. 14, Sec. 3).

The uplift of the roots in the Kathmandu nappes was repeated in the Khumbu nappes. North of the main range of Numbur-Karyolung-Kangtega, a still higher range, the Everest-Makalu group, was destined to appear (Fig. 24).

The 8000-m. peaks of central Nepal exhibit an astoundingly symmetrical summit level, which corresponds fairly accurately with the 8000-m. zone. Its altitude is entirely the work of a single root uplift. The Everest group, on the other hand, owes its dominating height to two consecutive phases of root upthrust. Two such phases—when seen in longitudinal profile from west to east—would be expected to be found where two root systems were superimposed. This is what took place in

the terrain of Khumbu, where the Kathmandu nappes and the Khumbu nappes play a great part in the formation of mountains.

The special tectonic structure and the double phase of mountain-building made possible the formation of a high valley in the main chain draining to the south, unique in the Himalayas and called in the language of the Sherpas, Khumbu. This high mountain valley ringed around with huge peaks, with its large and beautiful villages at heights between 3600 and 3900 m., which provides a safe passage over the Nangpa La (5800 m.) to Tibet, having a climate something between that of central Nepal and the deserts of the Tibetan plateau, is the present-day home of the Sherpas.

12. SLOWING-UP OF THE MOUNTAIN-BUILDING

After the formidable uplift of the nappe roots to the height of the present-day summits, the forces which built up the mountains did not immediately cease to operate. But during the gradual slowing up of these forces further, if slightly less far-reaching, structural changes took place.

Immediately after the steep inclination and uplift of the nappe roots and subsequent slicing (*Verschuppung*) of the zone directly adjoining the roots to the north, a crushing of the Himalayan zone ensued. This great sedimentary basin of the Tibetan marginal syncline lying between the original Himalayas and the Tibetan highland rim, displayed the thickest and most complete series of sedimentation. As a direct result of the fore-mentioned tectonic crushing, the complicated Tibetan marginal syncline was evolved from the former wide trough (Fig. 14, Secs. 3 and 4).

In the Everest range the south face exhibits folding and slicing in a southerly direction (i.e. the Everest *Schuppe*). On the northern side, on the other hand, the slicing was directed towards the north (Fig. 14). These Schuppen changed to folds as they approached the north, which in their turn exhibited a progressively decreasing intensity. This resulted in a gradual transition to the slightly undulating Tibetan plateau. In the Everest group the structures of the Tibetan marginal syncline are well manifested, particularly in the eastern portion. The tremendous eastern faces of Makalu-Chomo Lonzo and Lhotse-Everest in conjunction with the partial, exceptionally steep axial down-gradient towards the west, afford a sectional insight into the construction of the syncline (Figs. 16 and 19). Owing to the axial rise towards the Arun anticline in the east, the crystalline bedrock of the syncline made a predominating appearance. The structures when seen in cross-section, however, cannot so readily be attributed to the same cause; for example, the Chomo Lonzo-Nuptse Schuppe shown in Section 1 of Fig. 14 does not just end in the air, so to speak. It is not merely a tectonic klippe (nappe outlier) but owing to the

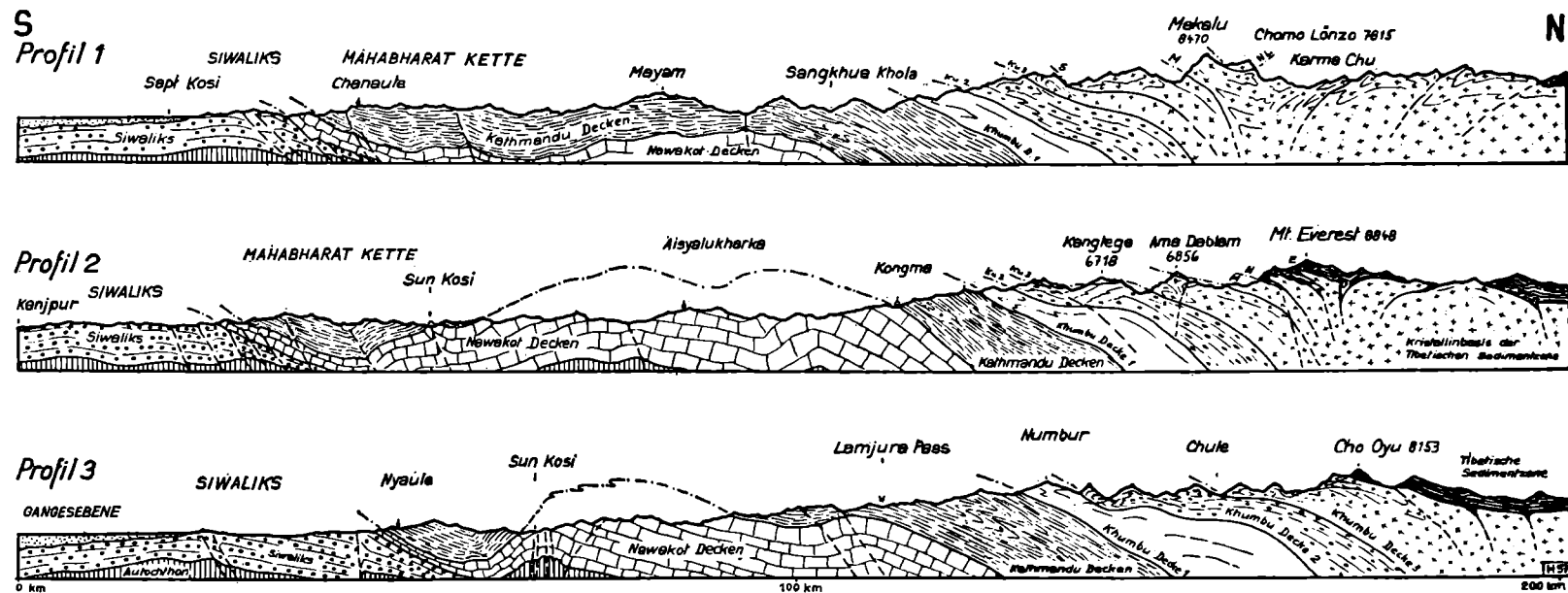


FIG. 19. Three tectonic profiles through the Everest group, from the Ganges plain to the Tibetan plateau, by Toni Hagen, 1956.

axial down-gradient towards the west is rooted further to the west of the cross-section in question (Fig. 16).

Especially worthy of note are the extensive back-folding phenomena, which are to be found along the northern edge of the root zone throughout almost the whole of Nepal, from the Arun to the Saipal (Fig. 12, Sec. 4). These phenomena are well known in the Alps. South of the nappe roots, i.e. at their back, the mesozoic sediments are abundantly folded towards the south (e.g. on Lake Lugano).

The slicing is very marked and much more extensive than might be imagined from observations made only on the south face of the Everest-Makalu range. This explains why the sections through Everest made by A. Lombard and P. Bordet are shown as relatively uncomplicated (Figs. 20 and 21).

The complexity of the Tibetan marginal synclinorium is well demonstrated further to the west, where not only its crystalline bedrock, but also the sedimentary contents of the former Thetys Sea is disclosed. The sediment zones of the upper Buri-Gandaki Valley (north of the Manaslu range, Fig. 8), or Manangbhot and Muktinath (north of Annapurna, Fig. 12), of Langu (north of Dhaulagiri) and also of Saipal, form part of the finest geological features which the earth has to show. Here is to be found a practically unbroken series from the cambrian to the chalk era, and the complicated folding and sliced structures are represented so clearly by the lithologically well-differentiated rock strata that it might have been taken straight from a textbook of geology (Fig. 12, Sec. 4). But it should be pointed out that the western marginal syncline is not directly connected with that of Everest for, as has already been stated, the most northerly nappe roots to the west diverge from the main root zone and the root cores become detached, as maintained by geologists.

The final phase of impact did not fail to leave its traces in central Nepal, in the region of the overthrust nappes. The bedrock of the Nepalese Mittelland together with the superimposed Nawakot and Kathmandu nappes, was uplifted to form wide anticlinal arches, synclines, anticlinal fractures, curves and faults (Fig. 12, Sec. 5 and Fig. 19).

Upon the whole, three main structures can be recognized throughout the Mittelland, stretching more or less from the Sikkim boundary in the east to the Nepal western frontier. These are, from north to south, as follows: the Himalayan pre-anticline, the Mittelland anticline and the Mahabharat syncline (Fig. 18).

The Pike anticline in the Everest longitude is an example of the Himalayan pre-anticline (Fig. 13). The curved, southerly course of the axis of this great arch is at the same time a feature of the old Everest block, its corresponding root curve and its transverse synclines. Even the

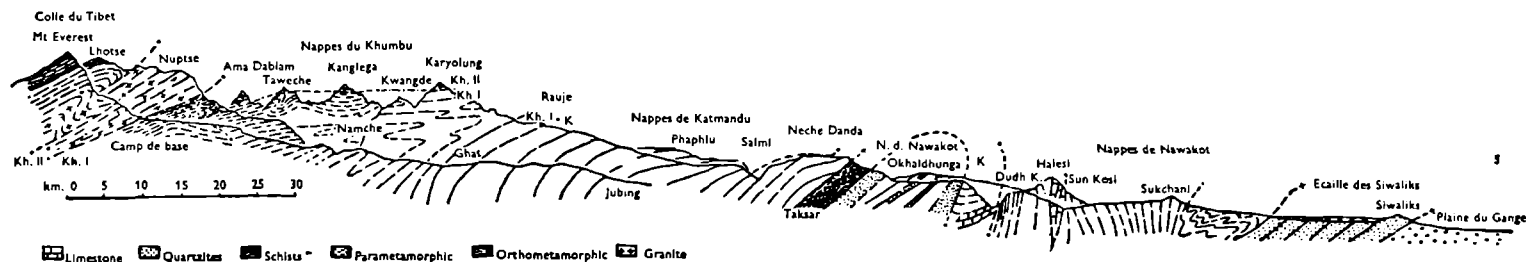


FIG. 20. Geological profile from Mount Everest to the Ganges plain, by A. Lombard, 1958.

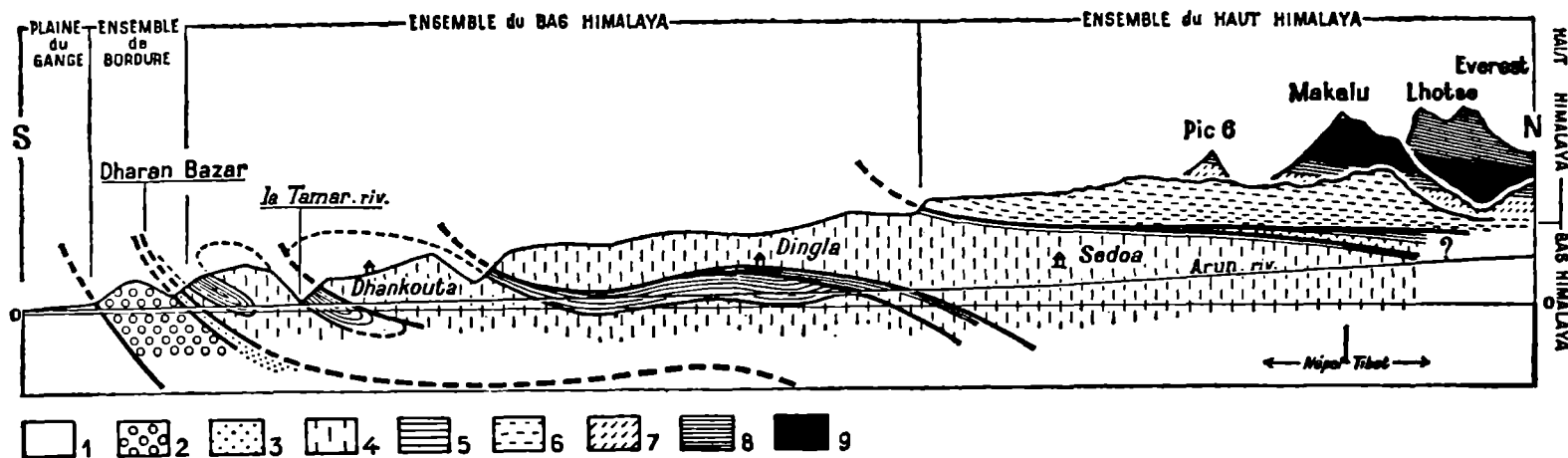


FIG. 21. Tectonic profile through the Everest group, by P. Bordet, 1955 (Twofold exaggeration). According to this profile the Everest group appears to owe its commanding altitude solely to uplift.

1. Ganges plain. 2. Siwaliks. 3. Sanguri Series (Nawakot Nappes by T. Hagen). 4. Migmatite of the 'lower Himalayas'. 5. Epimetamorphous covering of the migmatite of the lower Himalayas. 6. Barun gneiss. 7. Barun migmatite. 8. Black Barun gneiss and Everest series. 9. Makalu granite.

complicated structures within the Everest transverse synclines are still affected by the interruption of the Pike anticlines south of Junbesi (Fig. 13).

Even away from the Everest cross-section the Himalayan pre-anticline does not run in a straight line, for the remaining tectonic root curves have exercised their influence upon it and split it up into separate convex sectors converging towards the south. It is not difficult to determine from the tectonic map (Fig. 18) the manner in which this partition stands in direct relationship to the root curves.

Unlike the Mittelland anticlines the Himalayan pre-anticline had exercised little influence upon the formation of valleys. It differentiates from the curved type of fracture of the former by a gentle, level crest which did not have the effect of shattering the rock formation. Thus the Himalayan pre-anticline lies within the region of the uplift zone of the roots, and in consequence is not conducive to valley formation (Figs. 18 and 13).

The Mittelland anticline is of a different character to that of the already described Himalayan pre-anticline, for in place of the usual curved crest, steep or vertical upthrust strata predominate, forming a so-called anticlinal fracture (Figs. 21 and 23). The anticlinal fractures even change to actual curves in certain areas. From this we may deduce that originally vertical movements took place in the region of the present-day Mittelland anticlines and not until later were the strata along the faults and fractures (by horizontal pressure) thrust upwards to form anticlinal fractures.

Generally speaking the Mittelland anticline is unsymmetrical with an enormously developed northern limb and a secondary southern limb, partially tectonically squeezed off (Fig. 19).

In the Everest cross-section we find the Mittelland anticline in the bed of the Sun Kosi and Tamur rivers. This, however, is only a small portion of the structure in question, which runs across the whole country almost without a break at the northern foot of the Mahabharat chain. The Mittelland anticline too, shows the effect of transverse structures. In the Kathmandu sector, for example, it is curved round on both sides towards the north, in fact in conformity with the valley of the Sun Kosi it forms a semicircular arc, a truly unique example of an anticlinal structure. At its north-eastern end it even changes over to the Himalayan pre-anticline (Fig. 18). Of particular interest is its course in the Everest-Arun longitude (Fig. 13). To the east of the Arun River it follows the Tamur and bends off into the tectonic window of Angbung. The appearance of the Angbung zone in this window is a direct result of the eroded Tamur anticline.

The Mahabharat syncline joins on to the south of the Mittelland anticline, this feature also traverses the entire country again practically without a break from east to west (Fig. 18). It is also predominantly unsymmetrical, having a reduced northern limb and a thick tectonically accumulated

southern limb. The reduction of the northern limb is undoubtedly loosely connected with the curves of the Mittelland anticline (Fig. 19).

The Mahabharat syncline is also split up into sectors, which may be traced back to transverse fractures. East of Dharan it bends away from its normal west-east course towards the north-east and even towards the north, eventually almost reaching the root zone west of Kangchenjunga.

Taking a general survey (Fig. 18), it seems clear that all the three described main structures south of the main chain (Himalayan pre-anticline, Mittelland anticline and Mahabharat syncline) have stood in genetic correlation with one another and in particular with the transverse faults. This stage of the pressing together of the Mittelland might be called the Mittelland stage (Fig. 12, Sec. 5).

The above-mentioned structures have had a great influence upon the formation of the landscape. At some former date erosion attacked first of all the raised portions, the anticlines. Here the tectonically deeper parts, the Nawakot nappes, appeared below the Kathmandu nappes in the form of tectonic windows and half windows. Thus we find today in the sector south of Everest, the great tectonic window of Okhaldhunga and the Arun (Figs. 13, 18, and 19). The Kathmandu nappes are still mainly preserved in the Mahabharat syncline.

The anticlinal fractures must be of great importance in the formation of the river system in the Mittelland; this is especially true of the Mittelland anticline, the previous vertical movement of which created zones of weakness in the form of fractures and faults. These were more vigorously attacked by erosion. Thus, in the Mittelland, we find a relief which is opposed to the geological structure of the bedrock; the anticlines form valleys, whereas in the mountains of the Mittelland at the present time there are corresponding troughs. In this connection it should be pointed out that the type of rock has surprisingly little influence upon the formation of the major land forms of the relief. The main factor is the weakening of certain zones by structural events and the increased erosion at these zones of weakness.

Further occurrences in connection with the slowing up of mountain-building took place further to the south. We read in the foregoing section how the Siwaliks were deposited on the front of the Nawakot nappes. Their sedimentation was reflected in the development in the catchment areas of the rivers in the hinterland. The change over from marine to fluvial and even partly to aeolian sedimentation took place in the pliocene era. It is evident that not only changes in the hinterland but also tectonic events on the spot exercised an influence on the sedimentation. These tectonic occurrences increased in mountain-forming intensity, though within local limits.

When the pressure from the north slowed up, the most northerly portion of the Siwalik zone was sheared off from its bedrock and overthrust a few kilometres to the south. The zone lying immediately to the south was thereby squeezed together to form anticlinal fractures. The structures decreased in intensity towards the south and merged in gentle undulations into the Ganges trough. This bears a striking similarity to the Swiss molasse, which, as is well known, is divided into overthrust, folded and non-folded zones (Fig. 12, Sec. 5).

In the geological literature of the Himalayas the boundary between the tertiary Siwalik formation and the mesozoic and palaeozoic series of the overthrust nappes plays an important role. It has been termed the 'Main Boundary Thrust' since the beginning of Himalayan geology. Its meaning has undergone changes in the course of time. The abnormal tectonic contact was determined early on. In accordance with opinions prevailing at that time it was considered to be a fault, a curve, whose situation coincided with the primary northern edge of the former Siwalik zone. Today, however, it is well established that the Main Boundary Thrust represents a real overthrust plane. The Siwalik formations extend northwards below the overthrust nappes but there is no exact consensus of opinion as to the amount. Opinions vary between a few kilometres and as much as thirty. Personally I would incline towards the higher figure.

Siwalik formations have formerly been found in tectonic windows, outside Nepal; I myself established, in the Piuthan zone in west Nepal, that the latter was definitely overthrust on the top of the Siwaliks. I even noticed a tectonic semi-klippe (nappe outlier) of the Kathmandu nappes on the Siwaliks at the bend in the Sun Kosi River.

The Main Boundary Thrust was of particular interest to Arnold Heim. Earlier, in the Alps, he had made the fundamental discovery that the Swiss nappes (particularly at the Lake of Lucerne) were partially overthrust upon an old erosion surface of the molasse. Later, in the region of Darjeeling and east thereof, he came to the same conclusion about the Main Boundary Thrust as a result of his own observations.

I made the same discovery in the longitude of Everest. Near Udaipur Garhi the Kathmandu nappes (with fragments of the Nawakot nappes at the base) were pushed forward a few kilometres to the south along a front of about five kilometres in width (Fig. 13). It seems to have been due to an old erosion trough in the Siwaliks, for the strike in the Siwaliks does not follow the deep indentation to the south but runs in a straight line joining the lateral edges of the advanced Kathmandu blocks.

The overthrusts within the Siwaliks, and the overthrusting of the nappes *upon* the Siwaliks may be regarded as the Siwalik stage.

The nappe fronts were involved in this last overthrust action and were

folded and overthrust many times. The Nawakot nappes in particular and also the overthrust portions of the Piuthan zone in west Nepal show a folded structure of steeply graded folds tipped towards the south, which bear a striking resemblance to the Swiss nappes, either on the Säntis or on Pilatus. As distinct from the Alps, however, certain zones along the Main Boundary Thrust are distinguished by tremendous crushing of the rocks. This was not, obviously, caused only by the overthrusting but also by fractures which occurred at a later date. The rock bar of Chatra (Fig. 22) where the Arun enters the Siwaliks, is a particular example of this and includes a solitary fault zone. This region was for many years the object of intensive study by engineers and geologists working on a power station which was to have had the highest dam in the world. Fortunately the Indian government abandoned this project and started work on another site with an earth dam farther to the south. It is really not worthwhile attempting to construct large power stations at questionable sites from an engineering and geological standpoint when there exist so many possibilities for constructing them in much more favourable sites elsewhere.

13. THE MAHABHARAT RANGE FORMS A NATURAL PROTECTIVE WALL ABOVE THE MITTELLAND

We have arrived at that point in our history of the earth in which the Himalayas had risen to become the highest mountain range in the world, the territory lying to the south of the present-day Nepalese Mittelland, with its overthrust nappes was characterized by anticlines, synclines, arches, troughs, faults and fractures and the nappe fronts were already folded and the northernmost Siwaliks overthrust. From the south foot of the Himalayas an old land surface gradually sank from an altitude of approximately 5000 m. to about 1000 or 1500 m. above the Siwaliks. The actual Nepalese Mittelland was not yet formed, for its natural boundary to the south was absent. The old land surface was already cut into by valleys, in particular the old transverse rivers from the Tibetan highland rim had already carved relatively wide troughs through the Mittelland. These rivers more or less all flowed in a southerly direction with a relatively graded profile through the Kathmandu nappes in the Mahabharat syncline, through the narrow belt of the Nawakot nappes lying to the south and finally through the Siwalik zone in the Ganges trough. Simultaneously with the uplift of the mountains in the hinterland, the northernmost part of the Indian sub-continent sank still more (Fig. 12, Sec. 4). This sinking was considerable, amounting to several kilometres. But the Ganges trough, in the process of sinking, was continuously filled up with the detritus brought

down by the pleistocene rivers from the Himalayas. The quantity of alluvial deposits is really colossal, for it must be borne in mind that the Ganges trough in the longitude of Everest is 170 kilometres wide and this is its narrowest part. Approaching west Nepal it is 470 kilometres in width.

I became aware of the enormous extent of the Ganges alluvium in the course of the many flights I made between Calcutta and Kathmandu. It takes two to three hours to fly over the Ganges plain, but once past the Siwalik mountains Kathmandu is reached in twelve minutes and after another fifteen minutes the Langtang-Himal, the main chain, is left behind.

Thus the Nepalese Mittelland did not exist during the epoch just described, it merely formed a part of the southern flank of the Himalayas. Once again, and for the last time, tectonic forces came into play without, however, causing overthrusting or folding. This was the era of vertical movements: the massif of the Himalayas sank under its own weight as opposed to the immediate piedmont in the foreground (Fig. 12, Sec. 6). This might be loosely compared with the effect of throwing a heavy stone on to soft mud: it sinks in slowly and the soft displaced substance wells up round the stone. Albert Heim propounded the theory of the subsequent sinking of mountain ranges in his *Geologie der Schweiz*, with which he correlated the formation of the so-called 'Alpine marginal lakes'.

The cause of the submerging of the valleys has been attributed to isostasy. According to this theory a mountain massif, after uplift, sinks down again under its own weight below the level of the surrounding terrain. This is an attractive theory, but one cannot help feeling that the actual course of events must have been somewhat more complicated.

In Nepal the entire Mittelland sank in opposition to the zone of the Mahabharat syncline. In relief this subsidence operated as though the Mahabharat zone would rise relatively to it and the Mahabharat chain was formed. The relative height of the Mahabharat range over that of the Mittelland adjoining it to the north must have been in the order of about 1000 m. Even today the Mahabharat range rises up to 3000 m. (up to 3300 m. in East Nepal) over long distances, whereas the old land surface of the Mittelland is only about 2000 m. above sea-level.

The sinking of the Mittelland may in the main have been gradual, but the curve of the Mittelland anticlines may have played a part in it. We can term this stage of mountain building the Mahabharat stage.

Owing to the subsidence, the gradients of the great transverse valleys were reversed and the valleys were submerged. Large lakes were formed, similar to those on the north side of the main chain.

All that is left in Nepal today is the small remnant of the Pokhara Lakes.

Some very extensive pleistocene deposits with lacustrine clays establish the former existence of very large lakes of this type in the Kathmandu Valley, west of Gurkha, in the Sun Kosi and Karnali-Tila Valleys, and elsewhere. The stratification of the pleistocene lacustrine deposits indicates a very sharp rise towards the south, in the direction of the Mahabharat range, extending for about 250 kilometres from Kathmandu to Tinpani. Remnants of old valley terraces also extend in the Karnali-Tila Valley in a southerly direction without a break up to a height of about 400 m. These were not only fragments of the backwardly inclined valley terraces which were also intermixed with similar deposited strata like those on the Lake of Zürich, but there was definite proof of the submergence of the valleys by back tilting. The age of the deposits in the former Lake of Kathmandu was established as that of the pleistocene era, by the discovery of bones and teeth.

This identification of the back-tilted valleys in the Himalayas is important, for recent research carried out on the Lake of Zürich has established the backwardly inclined valley terraces there as pure hogbacks. It might therefore be considered plausible to deny *in toto* the existence of the 'submerged valleys' and to explain the formation of the basins of the Alpine marginal lakes as due to glacial action (masses of dead ice); but the total absence of co-operation with any tectonic phenomena is by no means conclusive.

The submergence of the Mittelland as opposed to the Mahabharat range had a further effect upon the river system: the gradually rising Mahabharat range acted as a barrier which obstructed the flow of the southerly flowing rivers from the Himalayas. Today only a few water gaps, caused by tectonic action, allow access for the rivers into the Ganges plain (*cf.* Figs. 17 and 24). The majority of the rivers flowing through the Mittelland from north to south collect in the longitudinal channel to the north of the Mahabharat Range, somewhat analogous to the manner in which the Aare collects the tributaries flowing into the Swiss Mittelland from the foot of the Jura mountains. This catchment junction is fulfilled by the Sun Kosi and Tamur rivers in the Everest area. They all flow into the Arun at practically the same spot and a little further to the south the united river, now called the Sapt Kosi, breaks through the Mahabharat and Siwalik ranges (Fig. 24). This water gap lies in the southern prolongation of the great Arun transverse anticline.

Whereas in the Alps submerged valleys (and corresponding lakes) are to be found on both sides at the edge of the mountains, conditions in the Nepal Himalayas are totally unsymmetrical. This is associated with the uplift of the Tibetan plateau and the original layout of the river system before the uprising of the main chain. Owing to this structure the main

watershed in the Himalayas is not coincident with the main range. The mechanism of the gradual but ever-dominating pressing upwards of the roots is absent in the Alps and the rivers drain both sides of the Alpine chain. On the north side of the Himalayas, however, the formation of reversed gradients is prevented by the irresistible uplift of the root zone.

There are pleistocene lacustrine deposits several hundreds of metres thick to be found in the upper reaches of the Kali Gandaki between Tukucha-Muktinath and Mustang, all that remains to be seen of a former lake some thirty kilometres long. It is evident that the uplift of the root zone was so intense and rapid that the Kali had no time to dig a deeper bed, and an impounded lake was formed.

Owing to the subsequent uplift of the root zone in the main chain (Annapurna and Dhaulagiri), the already-mentioned pleistocene lacustrine deposits in the Muktinath basin were also involved. They rise steeply from the north to the Annapurna chain.

Deposits of former lakes are to be found in all the valleys to the north of the root zone, and even in the Arun Valley and its tributaries there are former lake basins, e.g. near Kharta Sika or near Tashirakha.

14. VISIBLE TECTONIC MOVEMENT AT THE PRESENT DAY

Mountain-building was substantially finished with the rise of the Mahabharat range above the Nepalese Mittelland. The framework of the relief and present-day river system was thus evolved, and the arrangement of Nepal in natural regions dates back to those days (Fig. 17). There are, on the other hand, signs that movements and forces are still active in the earth's crust but they can in no way be compared with the events which led to the uprising of the mountains and the overthrusting of the nappes.

There are several methods of determining the continuation of movements of the earth's crust, i.e. risings and sinkings. For example, it is possible to form an indirect conclusion as to the 'rejuvenation' of the mountains from the valley formation. We will deal more fully with this subject in a later section.

Directly visible tectonic movements are generally rare. Even the terrible earthquakes of San Francisco and Japan were caused by transverse displacements of only a few metres. Small tectonic displacements are best recognized from air photographs, when, for example, a fault cuts across moraines or recent deposits of detritus.

In the longitude of Everest there are some very interesting features which reveal the tectonic movements still operating at the present time. For example, when crossing the most southerly part of the Siwalik range

between Tintale and Muksar (south-west of Udaipur Garhi, Fig. 22), I found on the southern slopes river shingle of crystalline rocks which is only found in the Mahabharat range, some kilometres north of the Siwaliks. The little river of Tintale (the Baijnath Khola) must, until a short time ago, have flowed directly south from the Mahabharat range. The Siwalik range between Tintale and Muksar must have been raised out of the Ganges plain in sub-recent times, for the above-mentioned crystalline river shingle lies exposed on top just as though it had recently been brought down by a storm. Owing to the raising up of the Siwalik range in this area, the Baijnath stream was diverted from its previous southerly course to the west and did not find its way down to the Ganges plain until it had joined forces with the Kamla River, twenty-five kilometres further west (Fig. 24).

South of Kampu Ghat, at the great bend of the Sun Kosi, the river leaves the Kathmandu nappes of the Mahabharat Range and enters the Siwalik zone. But instead of flowing south out into the Ganges plain, it turns off to the east and follows the boundary between the Kathmandu nappes and the Siwalik zone—the so-called Main Boundary Thrust—and does not reach the plain until after it has united with the Arun forty kilometres further on. Thus, the Siwalik Pass at Batasa, near the great bend at Kampu, is only about 150 m. above the level of the river. In all probability the ancient Kosi formerly, i.e. in sub-recent times, flowed from there south straight into the Ganges plain and was not diverted to the east until the uplift of the Siwaliks. An examination of the detritus in the Trijuga Valley would probably supply the proof of this, but it had to be abandoned owing to lack of time.

A transverse displacement was discovered in the Siwaliks, south-west of Namanta on the upper course of the Trijuga River. Its SSW-NNE strike points to a tie-up with the Everest-Arun transverse fractures.

In the same zone—we can see from this how important the Everest area is for the geological knowledge of the Himalayas—I discovered the earliest crust movements east of Dharan, in 1956. An unmistakable overthrust of more than twenty metres of light sandstone of the central Siwaliks over the recent upper Ganges alluvium was discovered near Kherwa (Fig. 24). West of this, near Dharan, the Ganges alluvium is sharply uplifted, it dips from Dharan to the south and west down to the Sapt Kosi (Fig. 24). This uplift also belongs to the present time and its catastrophic consequences are expressed in a westward shifting of the Sapt Kosi. Every year the river submerges freshly cultivated land and villages on its west bank, and at the same time leaves dry arid zones behind it to the east. The Indian government is trying to combat these forces of nature by the construction of an earth dam not far from the foot of the

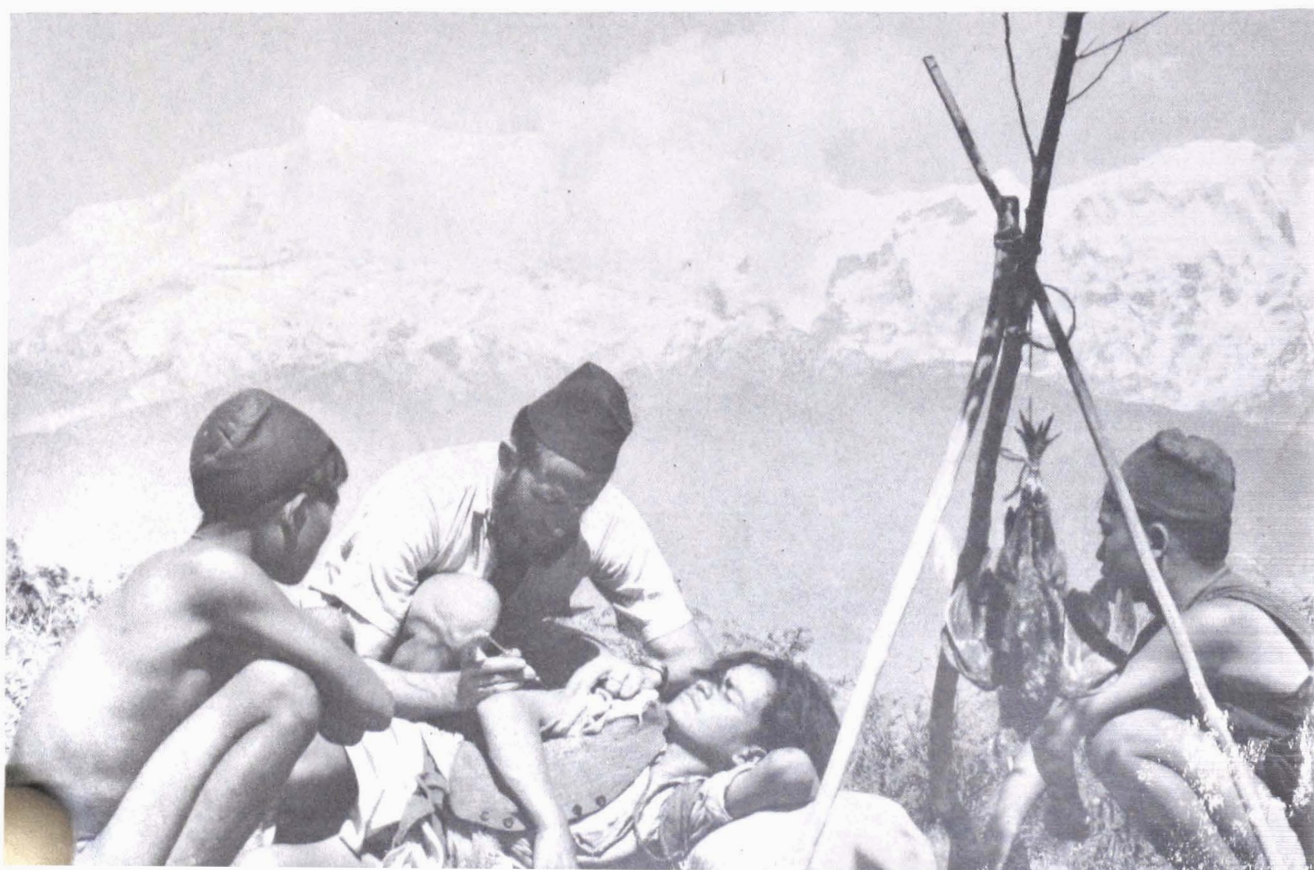
PLATE 13. A Tibetan Lama turning his prayer wheel. The influence of the Monastery of Thyangboche extends far into Tibet, and many pilgrims are encountered here





PLATE 14. Novices at the Monastery of Thyangboche. The younger of the two boys on the right is said to be a reincarnation of a Tibetan Lama

PLATE 15. Science combats gods and demons. An injured porter is injected with coramine by Toni Hagen, while the rest of the porters, stripped to the skin, offer up a fowl hanging from a tripod



Siwaliks. Let us hope that they will be successful. Later on I encountered more overthrusting over recent alluvium in the Siwaliks, amounting in some cases to 150 m. (e.g. near Petkot in west Nepal).

Fresh tensions in the bedrock and corresponding movements are also expressed by earthquakes. The calamitous Nepal-Bihar earthquake in 1934 (more than 10,000 dead) had its epicentre not far from here in the Ganges plain, i.e. in the longitude of Everest.

15. ARE THE HIMALAYAS STILL GROWING?

Having seen in the preceding chapters that tectonic movements (vertical movements of the crust and horizontal thrusting) are still going on today, we are faced with the question which is often asked, whether or not the Himalayas are still growing? In order to provide a satisfactory answer to this query we must direct our attention to the main mountain chain and in particular the valleys of the break-through rivers, their formation, cross-sections, and longitudinal profiles. What happened to these rivers when, during the Everest stage, the root zone of the nappes was suddenly uplifted to form the dominating mountain massif? Were they able, after that event, to deepen their beds? Could they create a graded longitudinal profile?

This question must be answered by a decisive No. The upward vertical movement had not yet finished and the rivers show no sign whatever of a graded profile. The cross-sections of the valleys indicate the convex type with steep and vertical lower slopes, so typical of the Himalayas. There can be no doubt whatever that uplift in the region of the main ranges still continues. The longitudinal profiles of the rivers on the other hand exhibit the pronounced knickpoint where they break through the main chain (Fig. 23).

The still incompletely graded longitudinal profiles of the transverse rivers are explained by recent and still-continuing uplift of the root zone. As regards the upper Arun Valley, which lies in Tibet, I was only able to make observations from frontier peaks, but in the Kali-Gandaki Valley I passed through the gorge on many occasions. There can hardly be a more stimulating experience for a geologist than a trip down the gorge of the Kali-Gandaki where it breaks through between Annapurna and Dhaulagiri.

The conditions obtaining in the Arun Valley are scarcely less impressive. Makalu (8470 m.) and Kangchenjunga (8525 m.) are 105 kilometres apart as the crow flies and between them flows the Arun with its bed only about 1600 m. above sea-level, near Hathia. If in place of Kangchenjunga we take Lumbasumba Himal which is only about 5800 m. high, the

distance from Makalu is reduced by about half, i.e. fifty-five kilometres. The Arun gorge between Num and Khartashika and Tashirakha exhibits a fine example of the knickpoint in the longitudinal profile. Remnants of an older valley formation at about 3300 m. near Hatia are still extant. The Arun has carved its young gorge here with valley flanks steepening towards the bottom (Plate 26). Over a horizontal distance of only thirty kilometres the sheer rock walls rise from this gorge 6000 m. up to Makalu! The Naktang Chu, the most important eastern tributary of the upper Arun, drops down to only 1800 m. at its confluence with the Arun south of Kimathangka over a horizontal distance of five kilometres (Fig. 22, Sec. 6 and Fig. 23).

At probably no other place in the Himalayas is the comparison with 'elevated islands' (*Hebungsinselfn*) so marked as when one views the Everest-Lhotse-Makalu massif over the Arun depression. This group of mountains stands upon its wide and level base, aloof and dominating all around it.

Based upon his observations on Nanda Devi, Arnold Heim has rejected the definition of the highest summits as elevated islands. We have seen, however, that the Nepalese 8000 m. peaks are not just remnants of erosive action of a former mountain massif of approximately 8000 m. altitude. The groups of Nepalese 8000-m. peaks represent zones of augmented uplift, even if the Everest group exhibits synclinal structure in its longitudinal profile. It was G. O. Dyhrenfurth who coined the expression 'elevated islands' as a result of his own observations in the 1930s.

From the above remarks it will be seen that the uplift still continues, but we cannot yet say whether, for example, Everest still continues to increase in altitude. For the question of erosion has not been taken into account, so that we do not know if Everest is positively growing. This all depends upon whether the uplift is counteracted by erosion or if it is in the ascendent. If the erosion is greater than the tectonic uplift, then the absolute height of Everest must be decreasing. This could only be determined, however, by not only a very accurate geodetic survey, but by surveys undertaken over long periods. As up to the moment this has not been accomplished, the growth of Everest must remain an unanswered question.

The 'growth' of the Himalayas must not be taken too literally. After the first Swiss Everest Expedition in 1952, led by Dr. E. Wyss-Dunant, newspaper reporters asked about the growth of the Himalayas. Dr. Wyss jokingly remarked that Himalayan expeditions must hurry as otherwise the mountain might get too high to climb. A few days later I found that this remark was the subject of a serious article in an Indian newspaper.

16. CONDENSED AND SIMPLIFIED TIME-SCALE, REDUCED TO HUMAN STANDARDS

Section 10 showed how the course of the earth's history was speeding up, both biologically and abiotically. The expansion and magnitude of mountain-building also changed at the same time as this acceleration. Old mountains occupy a much greater area than young ones, but they are often correspondingly less lofty. The continents increased with every mountain formation, as new mountains were joined on to their edges. As a result of this there was always less room for the succeeding mountains. The mountain-forming forces, which are scarcely less powerful than in primeval times, found their field of operations more and more restricted because of this; that is to say their effect was concentrated in a relatively narrow zone. The consequent reaction was thus more violent, for the mountains grew constantly higher and were raised up much more rapidly. The effect might be compared to a tamped or rammed explosive charge, the local effect of which is much more powerful than with an ordinary charge.

It is difficult for a human being having a span of life of only a few decades, to form an idea of the course of the earth's history and geological epochs. In order to make this more comprehensible we propose to compress the history of the earth into the span of a single year. We therefore fix the creation of the earth, i.e. the formation of the first rocks after the cooling-off period (about 2000 million years ago) as the beginning of the year, and the beginning of our era after the birth of Christ as the end of the year, at midnight on 31 December. Thus, a human life of seventy years reduced to this scale does not last more than a second.

The first half of earth-history is largely veiled in darkness, owing to the absence of fossilized living creatures. The first living creature comes on the scene at the beginning of July, this is the so-called 'corycium enigmaticum', best translated as the 'enigmatic small sack'. It is not known exactly what sort of a creature it was, whether plant or animal, which left behind in Finland the small oval sacks of 2-3 cm., formed of carbonaceous matter. It was about this time (about 1200 million years ago) that the Aravalli range was uplifted in India.

A chronological survey—with relation to our year of the history of the earth—is given in the following table.

First rocks	2000 million years	1 January
Aravalli range	1200 million years	Beginning of July
Corycium enigmaticum	1100-1200 million years	Middle of July
Trilobites (crustaceous)	600-250 million years	20 Aug-17 Nov

First Fish	500 million years	Beginning of October
Amphibians	310 million years	9 November
Reptiles	280 million years	12 November
Mammals	190 million years	28 November
Birds	160 million years	1 December
Tibetan Highland Rim (Thorung stage, first mountains out of the Himalayan geosyncline)	70 million years	19 December
Folding of the Alps (Main Stage)	20-25 million years	27 December
Nawakot - Kathmandu over-thrust	10-16 million years	29 December early morning
First ancestors of man (oreopithecus) in the Lower Siwaliks	10-15 million years	29 December 17.00 hours
Tibetan Stage	800,000 years	31 December 20.39 hours
Sinanthropus	700,000 years	31 December 21.04 hours
Everest Stage	800,000-500,000 years	31 December 20.39-21.54 hours
First Ice Age	500,000 years	31 December 22.04 hours
Neanderthal Man	300,000 years	31 December 22.45 hours
Mahabharat Stage, Kathmandu Lake (Mahabharat range raised about 300 m. in last 5 mins.)	less than 200,000 years	31 December 23.10 hours
Last interglacial period	90,000-25,000 years	31 December 22.50-23.37 hours
Last Ice Age (max. advance)	20,000-30,000 years	31 December 23.54 hours
Highest state of civilization in proximity to Himalayas. (Harappa)	4,000 years	31 December 23.59 hours
Penetration of the Ayrans into India		31 December -12 seconds
Birth of Buddha in Southern Nepal		31 December -1 second
Birth of Christ		31 December midnight
First mention of Everest by Jesuit father in Peking, 1717		31 December +25 seconds
Everest recognized as highest mountain by Survey of India, 1852		31 December +27 seconds

First conquest of Everest by Hillary and Tenzing, 1953	31 December + 29 seconds
Sherpa life in Khumbu for about 700 years	about 10 seconds

From the above table can be seen the enormous length of life of the trilobites, about three months, compared with three days for the human race since the ancestors of *Oreopithecus*. The first men lived shortly after the main overfolding of the great nappes in the Himalayas (evening of 29 December) and were alive at the time of the uprising of the roots, i.e. the formation of the highest mountains! According to our chronological calculations the main uplift in the Everest stage lasted about an hour and a half and in this period of time primeval Everest was uplifted about 3000 m. It must have been extremely unpleasant for those people living in the Siwalik zone. It must not be thought that the Himalayas were raised by natural cataclysms in a piecemeal manner. The uplift was, however, accompanied by such cataclysms (earthquakes, rock falls, floods, diversion of rivers, volcanic eruptions, extrusion of rocks, etc.). A conception of the intensity of these natural cataclysms can be arrived at if the earthquakes in the Himalayas which occur approximately every thirty-five years (last Nepal-Bihar earthquake in 1934) are transposed on to our time scale. An earthquake of this type happens every half second, with rock falls, diversions of rivers and tens of thousands of dead. One may be sure that the earthquakes occurring at the time of the uplifting of the roots in the Everest stage were no less numerous and intensive than they are today at the approaching end of mountain-building. The comparative figures of erosion in our earth-history are not less impressive. Based upon the assumption that 13 million years are necessary to erode a mountain down to a plane surface (peneplain), this erosion only lasts for two days according to our time-scale! The erosion figure of approximately 1 mm. per annum as calculated by Heinrich Jäckli for the central Grisons, corresponds in the above time-scale to a surface loss of mountain area of 240 m. per hour.

I should like to point out at this stage that a positive determination of the age of the mountain-building stages is somewhat questionable, unless the strata are richly furnished with fossils and that not all the rock samples and fossils have been removed. The sequence of the various stages will scarcely have been subjected to great changes, but any positive dates might be subject to later corrections. Thus they might have a preponderant effect in reducing the determination of age. The more results of age determination achieved by the new carbon method (so-called C-14 method) the more for example will the last ice age and interglacial age be

advanced towards the present day. On the other hand there is a lapse of time between the range of the C-14 method and the uranium-lead method previously mentioned, of a few hundred thousand years, the direct age group of which it is not yet possible to establish. The unusually youthful age of the Himalayas is a little strange to the geologist used to Alpine geology. One thing, however, is quite clear and that is that in the formation of the Himalayas we have to do with an intensity and tempo unknown to former geological times.

17. THE HIGHEST MOUNTAIN CHAIN IS NOT THE MAIN WATERSHED

In a great mountain massif it is usually the case that the highest chain is the watershed from which rivers flow down on all sides. Even if the symmetry is slightly interrupted by geological structure or by differing erosion on both sides of the range, the fact that the highest elevation is the watershed is still the basic principle.

The Himalayas, however, are an exception to this general rule. We have seen in our historical section that the river system had taken shape before the main chain had attained its present height, and that the rivers had forced a way down through the main chain from the north simultaneously with the uplift of the mountains.

If we consider Fig. 17, it will be seen that the rivers flowing from north to south were held up on four occasions behind mountain barriers, which they eventually broke through together.

The first barrier was the Tibetan highland rim, the second the main chain of the Himalayas, the third the Mahabharat range, and the fourth and last—of much less importance—the Siwalik range.

The Everest group, the subject of our investigation, is enclosed on both sides by transverse rivers, the Rongshar Chu and the Kang Chu to the west and the Arun to the east (Fig. 22). The latter river is of predominant importance. It drains an area of about 30,000 square kilometres lying to the north of the Everest group, whereas the Rongshar Chu and Kang Chu, which unite to form the Bhote Khosi, have a catchment area of barely 2000 square kilometres.

The catchment area of the Arun extends from Shisha Pangma, i.e. from the longitude of the Ganesh Himal (west of Kathmandu) right across Sikkim. The watershed between the Ganges system in the south and the Tsangpo-Brahmaputra in the north is situated 115 kilometres to the north of Everest, where it rises to 6500 m. (Fig. 22). The area between the main chain of the Himalayas and the watershed is at its greatest in the basin of Shekar Dzong. From here the ridges of the watershed and the main Himalayas converge towards the west and east.

80 kilometres to the north of the Tibetan marginal range. From this surprising development of the Arun River system on a large scale, one can form an impression of the far-reaching effect which the Arun transverse anticline exercised upon the building of the Himalayas in this sector. We can thereupon form an indirect conclusion that the pre-orogenic Arun transverse structure has actually continued right into the Tibetan plateau, as has already been conjectured in Section 6 of this chapter.

The prominent bend in the Tsangpo near Lhatse Dzong, where it suddenly changes its direction towards the north after having flowed for several hundred kilometres in a west-east direction, did certainly not occur by chance, for the prominent transverse Tsangpo Valley near Lhatse lies in the same plane as the northerly continuation of the Arun Valley with its transverse fault (Fig. 22).

In the region of the Tibetan plateau the relief corresponds to a far-reaching degree with the geological structure of the bedrock, in a similar manner to that obtaining in the Jura. Mountain ridges and crests lie on tectonic arches and the rivers follow the tectonic troughs. The structures must be relatively young. As in the section under consideration—the Shekar Dzong basin—the strike of the geological structures is in a WNW–ESE direction; this orientation prevails in the river system (Fig. 22).

The Dzakar Chu and Ra Chu (*Chu*=stream) flow down the northern slopes of Everest towards the north and owing to their steep gradient force a way through the geological structures. Having attained more level ground near Tashidzom, the Dzakar Chu turns off to the east, i.e. in the direction of the geological strike. The same thing happens to the Ra Chu near Tingri Dzong where it meets the Phung Chu which also flows in an easterly direction. After about 100 kilometres or so the Phung Chu changes direction once again and from Kochak onwards cuts across the geological structures. From here onwards in its course towards the south it becomes a transverse river (*Durchbruchfluss*). Near Kochak several other important rivers flow in from the east, such as the Chiblung Chu and the Yara Chu (Fig. 22).

This configuration is not fortuitous, for the Yara Chu flows round the Arun crystalline anticline which dips to the north, in a wide, sweeping bend. From here the united Phung Chu flows along the NW flank of the Arun anticline and descends in terraced formation in increasingly deeper strata into the crystalline core of the Arun anticline. A few kilometres north of Khartashika it enters the root zones of the Kathmandu nappes which at this point extend far to the north (Figs. 14 and 23).

We have therefore seen how the main chain of the Himalayas channels all the rivers rising to the north into the Arun and how this river with

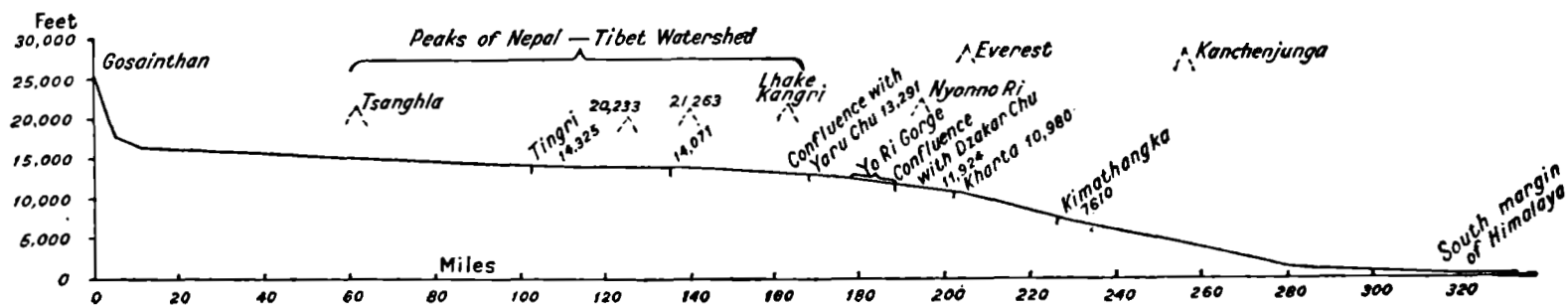


FIG. 23. Longitudinal profile of the Arun in Nepal and Tibet, by Wager. The steep slope below Kharta is worthy of note.

consummate force breaks through the main chain at a geologically predestined spot.

The Mahabharat range performs a similar role farther to the south. This range concentrates all the rivers rising to the south of the Himalayas and again at a geologically predestined point the united river—now called the Sapt Kosi—breaks through the Mahabharat and Siwalik ranges (Fig. 23).

This same activity is repeated in the Siwalik range to a lesser extent, in that the Trijuga River flowing from the west joins the Sapt Kosi and further to the west the Kamla River collects a few small streams before it enters the Ganges plain.

Whereas on the Tibetan plateau to the north of the main chain the rivers flow in synclinal valleys, in the Mittelland the relief is formed in inverse ratio to the structure. The great valleys run in anticlinal structures. In the Siwalik zone all the valleys are so-called isoclinal valleys, i.e. valleys of uniform strata running parallel to the geological strike.

Morphologically the so-called equality of summit levels (*Gipfelflur*) play an important role. An imaginary cross-section through all the summits shows a dip towards the basis level. The relative height, extent, and form of this cross-section affords a standard for the subsequent erosion. As is the case in the Alps, the present summit level in the Himalayas is not dependent upon the type of rock. On the other hand, in the Himalayas it presents some interesting characteristics by reason of the special tectonic features. This fact has been remarked upon by Wager.

However, equality of summits varies considerably, depending on whether the profile is in the neighbourhood of a transverse valley or lies along the axis of a tectonic root zone with a mountain massif. If the summit of a very extensive massif—disregarding the intermediate young transverse structures—is projected upon a single average profile, a false interpretation of an average summit level is obtained. This is partly the case with the longitudinal profile of the Arun River by Wager shown in Fig. 23.

According to Wager the exaggeration of the vertical scale of the Himalayas above the Tibetan plateau of 4000 m. corresponds to the restored isostatic equilibrium after the excavation of the valleys. In his book, *Everest 1933*, Wager stated as follows: 'If the mountains in the Sikkim Himalayas were to be levelled and the valleys filled up with their debris, a plateau would be formed the surface of which would dip gently towards the Ganges plain, and in the region of the present main mountain chain the plateau would have an altitude of about 4600 m. which is considerably less than that portion of the Tibetan Plateau lying immediately to the north thereof.' Wager here presupposes the former edge of the

Tibetan plateau as sloping gently towards the south. The rivers forming part of the Ganges system had their origin there but owing to intensive erosion have cut back from south to north. In order to compensate for the extensive erosive action the edge of the Tibetan plateau would be directly uplifted. Wager differentiates between two major phases in the formation of the Himalayas: 1 Uplift of the Tibetan plateau and 2 Uplift of the southern edge of the plateau as isostatic compensation. Besides the excavation of the valleys there was further intensive action by the melting of the quaternary ice sheet, which further increased the isostatic compensatory movement. Odell, in 1925, made a special investigation of this factor.

It is quite clear from the above remarks that the particular form of equality of summit levels and especially the elevation of the summits about 3000 m. above the Tibetan plateau, is dependent upon tectonic effects not limited solely to vertical movements.

It is curious how too much importance is ascribed to the ice ages and the present Polar ice caps as factors contributing to mountain-building.

The culmination in the cross-section of the summit levels, or, in other words, the line joining the highest summits, is moving northwards owing to extensive erosion from the south. From a tectonic point of view, almost all the Nepalese 8000-m. peaks today lie immediately to the north of the uppermost nappe roots, in the marginal overthrust areas. The formation of the highest summits thus has causative connection with the nappe tectonic structure.

The ice ages exercised considerable influence upon valley formation in the Himalayas. Erosion was caused less by glacier action than by repeated intensive change brought about by the coming and going of the ice ages. As in the Alps, four great ice-age periods have occurred with corresponding ice-free intervals and periods of ice retreat.

As a direct result of this, old valley terraces and floors are to be found in great profusion. A detailed classification still awaits completion by future research workers. But a definite system is extant, ranging from the Tibetan highland rim through the Himalayas to the Mahabharat range. In the Kali Gandaki Valley, for example, it begins north of Mustang at about 4500 m., sinking to about 4000 m. at Muktinath: in the Kali gorge it is only indirectly visible by means of prominent valley shoulders. These drop down (apparently in a knickpoint) to about 3300 m. at the south foot of the Himalayas, gradually sinking to about 1500–2000 m. at the northern edge of the Mahabharat range.

There is a valley of this system to be found on the upper course of the Uttar-Ganga in west Nepal with its old form entirely intact. The upper course was tapped off laterally by the Mayangdi and in consequence

erosion in the old Uttar Valley has remained unimportant since that time.

In the Arun Valley the corresponding old valley level is clearly characterized by extensive valley shoulders in the gorge from Kimathangka down to Dingla. Above the shoulders the valley sides are flat and on the whole concave, and the 8000-m. peaks tower above like isolated colossi. Below these the valley flanks descend to the depths with ever-increasing steepness. These are quite typical Himalayan valley forms with convex slopes. They reveal extensive erosion which has occurred since the time of the old valley course—the date of which it is at present impossible to determine. It should probably be ascribed to a former inter-glacial period.

18. FUTURE IMPORTANT HYDROLOGICAL EVENTS TO THE NORTH OF EVEREST

It might be of interest to take a look at possible developments in the future. According to the map shown in Fig. 22, the Mahpu Pass on the watershed between the Arun and the Tsangpo cannot be high. The Lo Chu, the highest stream of the Arun River system, at that place is, at the most, only 15 kilometres from the Tsangpo and certainly much less from its influx south of Manga Phu. The Arun has considerably greater erosive force (greater gradient, more precipitation), than the Tsangpo. The watershed will consequently move further to the north. After moving for a matter of only 15 kilometres it will have reached the Tsangpo and captured the 600 kilometres of its upper course to the benefit of the Ganges. In terms of geology this event can be regarded as imminent (Fig. 23). The Phung Chu rises only 3 kilometres from the Tsangpo to the west of the Kura Pass (5455 m.), and at the Seru Pass (5364 m.).

A further river capture is pending to the west of the Everest massif. The Phütse Pass, the watershed between the Rongshar Chu and the Ra Chu, is only about 200 m. above the valley floor of the latter stream to the south of Kyetrak. The Rongshar Chu, however, has much more erosive force than the Ra Chu as it flows south into the Ganges. It will therefore push back its watershed by means of erosion and before long will capture the upper course of the Ra Chu.

Incidentally, this will not be the first river capture in this area: the valley of the Ra Chu could very well be the former upper course of the Nangpa Bhote Kosi, which has been captured by the Phung Chu near Tingri Dzong (Fig. 22). Possibly the present upper course of the Phung Chu itself belongs to the old valley, which passed southward over the Nangpa La. The Nangpa Valley as far as Thami has no physical connection with its present glacier or river, it is completely buried in its detritus. The probability exists that formerly a much more important river carved

out this wide valley. The Nangpa La is more a level crossing than an actual pass. Exploration of the Ra Valley would undoubtedly provide either positive or negative proof of the conjectured river capture. River terraces—if any—in the ancient Nangpa Valley, must have flourished in the arid climate. In the affirmative case, we would be presented with the interesting phenomenon that an old transverse valley has again been barred by recent uplift of the root zone.

19. EVEREST'S GLACIERS ARE FED BY AVALANCHES

The glaciation of the ice-age eras has left its mark in the Nepal Himalayas. Notwithstanding this its influence upon the imprint of relief and landscape was astonishingly small, in fact it could almost be compared to that of the Alps. One difference, however, is that in contrast with Switzerland the whole Nepalese Mittelland remained ice-free. There are no glacier cirques to be found below 3000 m. and the lowest terminal moraines terminate between 2300 and 2400 m., near Chaunri Kharka south of Namche Bazar, for example.

It must be mentioned in passing that there are important differences between west and east Nepal. The winter snow line is much lower in the west. I found this out myself when I had to make my profiles above 1900 m. in SW Nepal in the winter of 1956–57 on ground thickly covered with snow, whereas in east and central Nepal mountains around the Mittelland were practically snow-free up to a height of 2800 m. In the high valleys, on the other hand, the winter snow cover was lower, as it is in the Alps. Thus, Chaunri Kharga nearly always has snow for short periods.

Moreover certain other lines of demarcation, which are concerned with climate, rise as one proceeds from south to north. This, surprisingly enough, is the case with the snow line, which is lower on the southern slopes of the Himalayas than in the so-called 'Inner Himalayas', lying to the north of the main chain. The vegetation and tree lines also rise as one goes towards the Inner Himalayas. At the same time settlements on the north side of the main chain are considerably higher than those situated on the southern slopes. On the southern slopes of the Himalayas, for example on Annapurna and Dhaulagiri, the highest Gurung and Mangar villages are at a height of only 2400 m.

North of Dhaulagiri, in Langu Valley, the highest Tibetan villages of Phopagaon and Phijorgaon are at altitudes of 4300 and 4100 m. respectively. There is no doubt that race plays an important part in determining the upper limit of settlements. The Tibetans are accustomed from birth to a mountain climate, but the Sherpa villages on the southern slopes of the

Himalayas between the meridians of Kathmandu and the Arun scarcely exceed 3000 m., while they are situated as high as 4000 m. in Khumbu.

The climate on the southern slopes of the Himalayas afford much worse living conditions than those on the northern side, and I experienced this for myself on more than one occasion. For example, in the summer of 1954 I was exploring the remote Langu Basin, far to the north of Dhaulagiri. The monsoon had broken some time before on the south side of the range, characterized by the unusually high cumulus clouds rising above a threatening bank of clouds to the south. This bank threatened to roll northwards but remained suspended above the Dhaulagiri massif. During the evening the incessant roll of thunder and vivid lightning was downright uncanny. All this time I was able to go about my work without interruption, for the weather remained fine. A few fore-runners of the monsoon crossed the main chain as far as the Inner Himalayas in the form of fine rain and moderate snowfalls, but that was all. When I had terminated my exploration in July, I descended the Kali Gorge between Annapurna and Dhaulagiri southwards to the Mittelland and the climate changed from arid to monsoon conditions in the space of a few kilometres. The vegetation was completely different and I had the greatest difficulty in reaching Kathmandu because of floods and broken bridges.

Other explorers have had similar experiences, especially the Swiss cheese-makers who spent several summers in the Langtang Himal. In the high mountains the monsoon is a period of storms, mist and fine rain, rather than copious downpours.

Of course there are local climatic differences to be taken into account. In the deep transverse valleys the monsoon occasionally advances over the main chain into the Inner Himalayas and we find, for example, rain-drenched mountain forests in the Arun and Karma Chu Valleys extending to the north of Makalu. The Rongshar Valley is also covered by very luxuriant forest growth as far as Gauri Sankar.

In the Nepalese Mittelland the monsoon usually lasts from the beginning of July until September; further south it begins earlier and does not finish until late autumn. It starts earlier in east Nepal than in the west and withdraws to the south-east.

The monsoon front advances northwards to the mountains but does not always cross the main chain. On many occasions I was able to observe the retreating monsoon front from high mountain summits. Many times I have seen the north-west plume on Everest from an aeroplane, while the monsoon was in full blast in the Mittelland and as far north as the foot of the main chain.

Fritz Müller, who spent a complete monsoon in Khumbu, has described the battle between two different winds. According to his statement the

monsoon only temporarily reached a height of 7000 m. and encountered a north-westerly katabatic wind at that height.

Khumbu, the valley system at the southern foot of Everest, occupies a special position as regards climatic conditions. Like the valleys of the Inner Himalayas, it is protected by a high range of mountains to the south (the Karyolung-Kangtega Range, Fig. 22) and is considerably higher than the Inner Himalayas, such as the Arun Valley. The monsoon discharges most of its precipitation on the southern slopes of the Kangtega Range while Khumbu, despite its position south of the highest range, receives relatively little rainfall.

This is confirmed by the wide valleys filled with detritus forming the upper courses of the rivers, which neither rivers nor glaciers are able to remove. The glaciers have a 'dried-up' appearance and their limited breadth is entirely out of proportion to the wide valleys. It is plain that their impetus and velocity must be low, for many of them have beds formed of their own detritus. In the course of his glaciological investigations, Fritz Müller measured the rate of flow of the Khumbu Glacier, which he found to his astonishment to average only 50 m. per annum.

These observations denoting low rainfall were not limited solely to the Khumbu or Everest region. A vain search was made for moraines both in the Rongshar and Karma Chu. The most striking example was the total lack of moraines in the Kali-Gandaki Valley, where it was to be expected that the huge ice-clad eastern face of Dhaulagiri would have left behind numerous traces of the ice ages in the valley; but the valley is predominantly arid-fluvial in form. A rather depressed-looking terminal moraine of the former main glacier is to be found at 2700 m. near Jomoson.

It was left to Fritz Müller to tabulate the numerous observations and impressions which for long had led experienced explorers to suspect the relative aridity of the high mountain regions. He measured the precipitation on the Khumbu Glacier from April to November which amounted to only 39 cm. and deduced from this that the figure was proportional to the total annual precipitation.

During seven months of the summer the Indian station measured a total of 166 cm. at Chaunri Kharka to the south of the Kangtega range at an altitude of 2400 m. while the Siwalik area had 199 cm. for the same period.

But the low amount of precipitation is not the only cause of the relatively small size of the Everest glaciers. Another equally important cause is the fact that there are no large névé basins to act as catchment areas. Fritz Müller puts the névé level of the Khumbu Glacier at 5600 m., which must be only a little above the area of the largest snowfalls of the summer monsoon. Above this height accretion of névé occurred but below

the line it was more than counter-balanced by melting. With perhaps the exception of the Chakri Glacier there are no extensive surfaces in the Everest area which could serve as névé catchment areas. Above about 6000 m. enormous rock walls are the order of the day. (In the Hongu Basin, south of and outside the Everest range there is, however, one very large névé basin.)

The Imja Glacier, for example, has no corresponding névé area (*cf.* Everest Map). It is fed by avalanches which roar down the huge south face of Lhotse. The Kangchung Glacier on the east face of Everest-Lhotse has even less névé. The foot of this face is at about 5500 m. and the glacier starts there, considerably below the zone of accretion. It is entirely nourished by summer avalanches from the stupendous wall.

The avalanches cease in winter and the high peaks are virtually free of snow, indeed Everest looks like a black rock buttress in the winter months. The so-called winter monsoon, so well known in the Mittelland has no significance in the mountains, at least not in east Nepal. It only takes place at lower altitudes, a fact which I was able to experience on many occasions.

At the end of December 1956, I arrived at a camp at Topke Gola, at an altitude of 3800 m. We were just at the upper limit of a sea of cloud which filled the entire Mittelland. Above these clouds a north-west storm was raging, but as it was a katabatic wind it was relatively mild. Next day I climbed a peak of about 5700 m. in the Lumbasumba Himal. The upper limit of the cloud bank rose with me as I climbed, driven by the wind which had backed to the south-west. When I reached the summit I was just above the bank of cloud, the surface of which was not as level as on the previous day. The panorama of the Everest massif towering above the Arun depression was overpowering. Towards evening, when I had finished my work on the peak, we began the descent into the bank of cloud. About 600 m. lower down light snow began to fall and when we reached the camp at 3800 m. the snow lay thick on the ground. Next day it was still snowing as we started on our way back to the Mittelland, and below 2400 m. it turned to rain. The sky cleared about midday. Next day on the top of a mountain thickly covered with snow I was more than a little astonished to perceive that the mountains to the north were completely free of snow above about 5600 m. The winter monsoon had only affected the lower altitudes, a phenomenon which I frequently observed on future occasions.

As regards altitude, Khumbu is not above the winter monsoon level, but it is sheltered from wintry showers by the Kangtega range. The valley itself is certainly covered by snow in the winter months but it does not extend up into the high mountains.





PLATE 17. The young abbot of Thyangboche Monastery, a reincarnation of the founder of the Monastery

PLATE 18. Interior of Thami Monastery. The Chief Lama on his throne. The bookshelves on the wall belong to the library and contain valuable old manuscripts



There is, however, one essential difference between winter and summer monsoons. The latter come from the south-east, while the former are caused by limited south-westerly depressions. Generally speaking the south-west wind is a fair weather wind whereas the south-east wind is invariably a harbinger of bad weather. This is particularly the case in the autumn at the end of the summer monsoon.

One must take care not to allow local weather observations to be too closely associated with too large an area. The winter monsoon in west Nepal is much more strongly developed than in central or even east Nepal. It is for this reason that in central and west Nepal with its south-westerly depressions it extends far beyond the main range as far as the Tibetan plateau. The first snowfalls of the winter monsoon in central Nepal take place at the New Year with astounding regularity. At the same time the mountains of central and west Nepal are covered with snow down to about 3000 m.

This short general digression upon the climatic conditions was necessary in order the better to understand the special glaciological phenomena in the Everest region. We will now revert directly to the glaciers themselves.

The glaciers as a whole are in retreat today, as they are in the Alps. The glaciers north of Manaslu are, however, an exception and their snouts are advancing over moraines covered with grass and even dwarf mountain pines. The number and extent of the retreats show an astounding resemblance to those of the Alps and they are particularly well developed in Khumbu.

The last two stages of retreat may well be compared with those which took place in the Alps in 1850 and 1910. Later on, however, the comparisons become more hypothetical. Older stages of retreat (Daun, Gschnitz?) are better developed in the valley of the Nangpa La. A compilation of the collected data of the different research workers is yet to be made, but it would be advisable to postpone this until the new photogrammetric map by Erwin Schneider of the whole area is available.

20. GEOLOGICAL EXCURSION FROM THE GANGES PLAIN TO EVEREST

We left the Indian railway station of Jaynagar on the Nepalese frontier behind us and were soon marching over the fertile alluvial plain of the Ganges. My little group of porters toiled along a swampy track deeply furrowed by ox-wagons.

It was a lovely warm October day and the ripe rice-fields were a beautiful yellow-green as a result of the monsoon rains. In places the harvest had already started although the fields were for the greater part still under water—water provided by the monsoon and a real gift from heaven. Far

away to the north the southernmost mountains rose abruptly out of the plain in the crystal-clear air. As we marched north the villages became more sparse but the inhabitants showed more traces of their Nepalese origin, characterized by their more robust frames, wide cheek-bones, and somewhat slit eyes. As the villages decreased, the track was easily lost and we were often forced to wade for long periods through fields covered with water. After some hours of this we reached the primeval forest which covers the northern part of the plain. Swarms of mosquitoes danced above the extensive swamps. This is the Terrai, the malaria-infested marshy strip along the southern foot of the mountains.

We felt oppressed by the silence and solitude of this dense forest. In the winter months there is considerable traffic on these roads which debouch into the Nepalese Mittelland. Today, however, we were alone, for the Nepalese wisely avoid the malarial zone in the hot months. As I was not carrying any load, my speed was greater than that of my porters. I was accustomed to doing this in order to allow more time for my geological research. In the Terrai forest, however, there was nothing of a geological nature to hold me up so that the distance between my Sherpas and myself correspondingly increased and I walked along deep in thought until I suddenly came across fresh tiger spoor or heard the well-known roar of a leopard in the near vicinity. I would then stand still and wait until my Sherpas caught me up. I would thereupon make a vow never to go so far ahead alone. This vow lasted until the porters caught up with me and I set off ahead once more. This little game continued until we had reached Muksar, the last village in the Terrai.

The so-called 'wild' animals are not really so dangerous after all. Unless they are attacked or frightened they avoid contact with human beings. When great tiger hunts are arranged, the tigers have to be literally driven out of the jungle. The great hunting parties of the former maharajahs were famous, when hundreds of elephants were employed in the drive and the tigers were started and chased around in ever narrowing circles.

Only rhinoceros and wild buffalo are really dangerous, for they invariably attack on sight. Fortunately I never met any of those. Only on one occasion we did hear the crashing of trees and bushes near our tent during the night, but we were able to scare the animal away by lighting a great fire—a large stock of wood is a *sine qua non* in jungle camps. Next day we observed with somewhat mixed feelings the fresh spoor of a rhinoceros which had passed our camp on the way to a nearby river.

The boundary between the alluvial plain and the mountain in the Nepal Terrai is sharply delineated, for the Siwalik range rises suddenly and abruptly out of the plain. Unfortunately I was not able to gratify my wish

to find a path leading from the last village up and along a mountain ridge, for I found to my disgust that the track continued along the bed of a stream deep into the Siwalik terrain. The expression 'path' is somewhat of a misnomer, for they are actually the well-known *Khola Pato*, to use the Nepalese native expression (*Khola*=stream, *Pato*=path). (The term is rather misleading; the word *Pato* could quite properly be omitted, for a narrow rivulet of crystal-clear water winds a tortuous way through a bed wide enough to accommodate one a hundred times its breadth.) The entire bed is covered with clean, washed, coarse, and partly blended white detritus. One can easily imagine the force of water which must flow through this valley down to the plains during the height of the monsoon. It was unbearably hot here without a breath of air, for the rays of the sun were reflected by the bare rock and detritus, and we were all extremely glad when we were able to leave the valley by a wretched track leading upwards to the heights.

The entire Siwalik region is deserted and covered with primeval forest, though not very dense. The wild, savage, hogback landscape extends for miles in all directions.

The scenic aspect of the country changed completely as soon as we left the Siwalik area to the north-west of Udaipur Garhi and crossed the Main Boundary Thrust into the overthrust nappes. The track, which had gradually improved, was bordered by pretty Nepalese houses faced with red mud, and the woods had retreated and given place to extensively cultivated and terraced fields, characteristic of the industrious Nepalese peasants.

After passing through a narrow tectonic zone of quartzite and schist with traces of dolomite, which should be considered as fragments of the Nawakot nappes, we came before long to the northward-dipping crystalline formations and palaeozoic schists of the Kathmandu nappes.

✱ We were treated to a surprising view over the lower-lying Nepalese Mittelland to the north from Runche Bhanjyang, 2200 m., on the Mahabharat range (Fig. 22), (*Bhanjyang*=pass). It was a gently undulating landscape when compared to the Mahabharat range. The most outstanding feature was the paucity of trees, for as far as the eye could see there were practically no woods. The nearest trees were in a great belt of forest at the foot of the Himalayas. The extremely steep slopes were still cultivated in terrace formation, so that the last foot of ground could be utilized for agriculture. Nepal has 8,400,000 inhabitants and a superficial area four times as great as that of Switzerland. When one bears in mind that the northern part of the Terai, the Siwalik zone, large areas of the Mahabharat range, and all the mountainous terrain are virtually uninhabited, it will be realized how very overpopulated must be the Nepalese Mittelland.

Sheltered on both sides by high mountains, it contains the major portion of the entire population. The large number of villages and individual settlements visible from Runche Bhanjyang is very striking. These red and white artistically decorated houses resemble toys in the wide open spaces.

The chain of hills in the Mittelland rise gradually from about 2500 m. to 3500 m. at the southern foot of the Himalayas. The general impression was that of a former gently inclined peneplain falling away towards the Mahabharat range from the southern foot of the Himalayas in which the numerous valleys were later carved out by erosion. Prominent valley shoulders situated about half-way up between the present valley floors and the summit levels of the Mittelland were reminiscent of an old valley system. The terrain above these valley shoulders was much more level. The present valleys were evolved by renewed erosion of the older valley system.

It was no easy matter to fix one's gaze upon the Mittelland, for the heights predominated. Just behind, the Everest massif (Everest itself was wreathed in cloud), Cho Oyu, Lhotse and Makalu soared to an unbelievable height above the plains. Their tremendous altitude made them appear isolated in their grandeur, as though they did not form part of the Himalayas at all.

We were seized with impatience to view these giants from close at hand, but the march through the Mittelland was rather wearisome owing to the great differences in altitude. From the Mahabharat range (2200 m.) we descended to the Sun Kosi (600 m.) and then climbed up over the Halesi Danda (2200 m.) down to the Dudh Kosi (700 m.). I stood lost in thought on the bank of this milky green river; its glacier water came direct from Everest. Once again the view from the Halesi Danda towards the north was stupendous, but on the other hand we were sadly disappointed when we reached the pass to the north of Aisyalukharka. Here the Everest massif was so close that it no longer stood out so imposingly above the immediate foreground. Moreover the intermediate range of Karyolung-Kangtega-Chamlang, barely visible up to now, came into its own. It even partially hid the summit of Everest, a good 2000 m. higher (Fig. 22).

But to return to geology. In the anticlinal fault of the Sun Kosi we encountered Nawakot nappes stratigraphically below the Kathmandu nappes. They consisted of limestone, dolomite and quartzite probably of the triassic era. Schists and phyllite were followed by deeper thick quartzite which encountered a great series of gneiss. At this point, doubtless, the Nawakot nappes, as opposed to central Nepal, included strata which went deep down into the paleozoic zone. The anticlinal fault in the Sun

Kosi Valley (the Mittelland anticline) is disclosed as an actual curve in this sector. The southern slope is reduced to a state of virtual unimportance.

The Sun Kosi anticlinal fault would be difficult to explain if we had not already observed on other occasions that an anticlinal structure was actually present, all the more so since the Mahabharat syncline adjoining it to the south is very firmly compressed at this point, in fact it displays a fan-like structure. We had previously observed the wide opening of this syncline to the east and west on making profiles in the vicinity. Lombard's expressed opinion (in 1955) of recumbent Kathmandu nappes is therefore comprehensible. The profile made by P. Bordet was based originally on local observations only.

Both above-mentioned authors, after considerable discussions between P. Bordet and the author of this work, corrected their profiles in a second edition (Fig. 20).

In view of the unsymmetrical arrangement of the Sun Kosi anticlinal fault with its extremely small southern limb and its correspondingly large northern limb, we marched from the Halesi Danda with its thick beds having an almost uninterrupted northerly dip, to the spot where the nappes overlying above the Pike anticline pass into their roots (Fig. 18).

The roots of the Kathmandu nappes to the east and west are united with their overthrust portions in the Mahabharat Range. They embrace the tectonic window of Okhaldhunga, 160 kilometres long, in which the recumbent Nawakot nappes appear. Another tectonic window is to be found near Dumlingthar in the Arun Valley (Figs. 13 and 18).

The further north we went, the more we were driven to use the valleys. The valley slopes became steeper and narrowed down to become gorges. We knew that we were far into the southern Himalayan range when we reached a point about midway between Chaunri Kharka and Benkar in the Dudh Kosi Valley. We were quite unable to see the snow giants for the convex valley slopes obstructed any view of the summits which lay further back. Here we were marching in the transverse gorge of the Dudh Kosi through the roots of the Kathmandu nappes. This formidable barrier marked a change in the population—we were now entering Sherpa country.

Anybody expecting to discover terminal moraines of glaciers of the Ice Age would be disappointed. There were quaternary deposits, to be sure, but very little sign of moraines. Had there never been any, or had they been removed by subsequent erosion?

The track, which now improved, climbed in zigzag fashion up the steep slopes of the spur between Thami Bothe Kosi and Dudh Kosi, until it reached the well-known Sherpa village of Namche Bazar (3880 m.).

And then suddenly, without warning, there was Chomo-lungma,

Goddess Mother of the World. The valley became less savage, the nearest slopes had been rounded off by glaciers of the Ice Age, and thick deposits of moraine detritus formed wide troughs in the background. The track from Namche Bazar to the celebrated Buddhist monastery of Thyangboche (3960 m.) provides a view of the Everest range and the surrounding peaks which must be one of the most magnificent on earth.

The monastery buildings are situated in a commanding position on a huge moraine. The Lamas are still as friendly as ever, despite the fact that they often receive strangers as their monastery lies on the route of the many Everest expeditions. I was particularly pleased to find some old acquaintances among the Lamas, whom I had met before in Darjeeling and on pilgrimages in the Himalayas.

One of the Lamas invited me to take tea with him in his cell. For once the roles were changed: he regaled me with Swiss chocolate, the best English tea, English rye bread, and other imported titbits, including cube sugar wrapped in paper! I had seen none of these things during my expeditions, which climbers always took with them as a matter of course. At the end of an expedition they would give any food left over to the friendly Lamas.

The reader can follow the rest of our trip on the accompanying map of the Everest region by Erwin Schneider.

Pangboche (4000 m.) is the highest Sherpa village inhabited all the year round. On leaving this we continued our way through sparse belts of forest as far as Tsuro Og (4135 m.) where the Imja Chu flows into the Lobuche Chubung. Ama Dablam (6856 m.) is the dominating feature on this part of the journey (Plate 6). It is an astonishing sight; the Tsuro Glacier pours down to the north-west from its west *arête* and reaches the main valley a little above Tsuro Og.

This was the first glacier we encountered without a névé field; it is entirely fed by avalanches falling from the steep slopes of Ama Dablam (*see* Section 19).

The largest of the older moraines terminate at the same place, i.e. at the confluence of the Imja Khola and the Lobuche Chubung. The best preserved is the old lateral moraine of the Khumbu Glacier on the crest between Dingboche and Pheriche and up as far as Dusa (*cf.* map). North of Dusa the crest of the moraine is about 200 m. above the valley floor. At this stage both the Khumbu and Imja Glaciers extended a little below the confluence of the present rivers of the same names. During the rapid retreat both glaciers left behind terminal basins including lakes, and subsequent silting up produced the fertile valley floors of Dingboche and Pheriche. The barley and potato fields of these summer pastures must be among the highest in the Himalayas.

The vast height and extent of the old lateral moraines could probably be compared with those of the Daun stage. However, the small advance of only 4 kilometres as compared to the present termination of the glacier north of Dughla suggests a younger stage (1600 ?). We saw in Section 19 that the extent of the glaciers in the Ice Age was not as great as that of the Alpine glaciers. The snow line of the Ice Age compared with the present day represents a lowering of only about 600 m. in the Himalayas, whereas it is double that amount in the Alps. During the period of retreat in the Daun stage, the lowering of the zone of accumulation in the Alps has been calculated at 300 m. but during the same stage it would amount to barely more than 200 m. in the Himalayas. The lowering of the névé line by 200 m. in the Daun stage in the Everest region, quite apart from possibility of underestimation—shows that owing to the characteristic relief of the Khumbu Valley with its walls rising to above 5300 m., the catchment area was scarcely increased at all. It would be interesting and instructive to measure the increase in area of the zones of accumulations for given lowerings of the snow line, based on Erwin Schneider's accurate photogrammetric map. Portions of important older moraines are still to be found above Pheriche.

We will now turn our attention to the impressive glacier basin of the Imja, which furnishes more data for the vindication of the above-mentioned thesis. The road from Pangboche to Dingboche is dominated by the huge south wall of Lhotse (8501 m.). This wall, including Nuptse, 7879 m. high, forms one of the most enormous barriers in the world, stretching for a distance of about 20 kilometres at an average height of approximately 3000 m. The atmosphere is so rarefied and clear that it is no easy matter to make an accurate estimation of the scale of the mountains. As seen from the great summer pastures of Dingboche, 4300 m., it looks as though the wall of Lhotse rose up immediately behind the glacier tongues of the Lhotse and Nuptse Glaciers. It seems scarcely credible that this tremendous wall is so far distant. Erwin Schneider's map gives an indication of the length of the Lhotse Glaciers; they extend 6 kilometres from the foot of the Lhotse face to the snout, with a fall of barely 1000 m. None of the four glaciers descending from the south face of Lhotse-Nuptse (*cf.* map) has a névé basin acting as a catchment area. The zone of accumulation with its lower limit of 5500 to 5600 m. is completely within range of the wall. The four glaciers are entirely fed by avalanches.

The amount of detritus accumulating on the glaciers is very considerable. It will be realized that avalanches emanating from a weathered face will send more detritus down on to a glacier than would come from a gently sloping névé basin without exposed rock faces.

The detritus carried down appears again on the surface of the lower part of the glacier, where the ice has melted, and the snout is completely covered by it. The snout is thus protected from further ablation, while melting still continues on the upper portions of the glacier. Dead ice forms underneath this detritus, leaving a piece of glacier having no connection with the main body. There is little doubt that masses of dead ice are a frequent occurrence in Himalayan glaciers. This is confirmed by the fact that there is a scarcity of snouts with streams flowing out of the ice.

The Khumbu Glacier is typical in this respect, for after leaving the alluvial plain of Pheriche the track ascends the steep moraine step of Dughla. Ice is not encountered until half-way between Dughla and Lobuche, where the track runs along the present crest of the moraine. At the same spot glacier streams emanate from the great lateral moraines (*cf.* map). Doubtless the ice extends further to the south from where it is last seen, under the thick moraine covering. Fritz Müller has confirmed this by his own observations.

The Khumbu Glacier has a further characteristic which is common to most of the Himalayan glaciers. Its bed is raised in the valley bottom and appears much too narrow for the wide valley. This is due to the small accretion of *névé* and the consequent low speed of flow which is not sufficient to carry away its own detritus. Nevertheless the Khumbu Glacier affords an indication of a *névé* basin in the so-called Cwm. (The flat portion of the glacier above the icefall north of Nuptse, so named by Eric Shipton, who discovered the route.) Fritz Müller measured the speed of flow of this glacier below the icefall at a height of about 5500 m. and found only a few places where the advance was more than 50 m. per annum, despite the fact that a much greater speed could have been expected in this section.

The Tsola Glacier, which flows from Tsolatse (6440 m.) down into the Tsola Valley, provides further impressive confirmation of the slow speed of glaciers. The snout lies well above the valley bottom on its own moraine bed (*cf.* map).

The Tsola Khola is dammed back to form a lake, the surface of which varies by 21 m. between the rainy and dry seasons. In the rainy season its length increases from 250 to 1250 m.!

There are some valleys which are dammed up by lateral glaciers, but nothing like the number of the well-known glacial-impounded lakes in the Karakoram, the bursting of which has often caused vast devastation right down into the plains. Of much greater import are the glacier lakes situated in former terminal basins and those on existing glaciers, such as the Imja. There is little doubt that there must be many lakes under the ice of the glaciers, and there have been many outbreaks of such underground lakes

though they have never had serious results. At the most only a few prayer-wheels and rice mills, which are of necessity constructed close to rivers, have been destroyed and perhaps a few bridges as well, but without many human casualties. Many of the bridges are only 'seasonal' structures, which have to be reconstructed after every rainy season. Occasionally the monsoon bursts with incredible fury on Nepal so that the discharge of certain rivers is increased a hundredfold and in consequence the population does not build houses or villages near the rivers. When choosing a camp site I always took great care that my tents were not too close to glacier torrents.

The stupendous south face of Lhotse-Nuptse (Plate 23) provides an excellent example of geological interest. The southern aspect of the face is certainly not suitable for a study of the normal west-east structures but on the other hand the north-south transverse structures can be read like a book, and they are of equal importance in mountain-building. The Nuptse granite shines out brightly, forming an unsymmetrical anticlinal arch (Nuptse and Lhotse anticlines) on either side of the Everest synclines. Between the two arches the Para rocks, the dark colour of which stands out in sharp contrast to the light granite, descend the southern face to the 6000-m. southern foot of Nuptse. This is extremely low when it is recalled that the same series rise to 8000 m. on Lhotse. In this manner the importance of the Everest synclines can be deduced. The Nuptse granite of both arches exhibits laterally extended strata but these disappear fairly soon as they rise upwards (Fig. 16).

The Everest pelites of Lombard lie on top of the Para series. These could be compared to the Cambrian Garbyang series of Heim or to my Chtilang series. The usually very thick silurian and Devonian limestone flecked with clay (similar to the Seewer limestone of the Swiss chalk) does not seem to have developed very strongly here. The lithological structural trend is the 'yellow band series', well known to me from numerous observations on Dhaulagiri and Annapurna and which from fossils could be ascribed to the carboniferous-permocarbiniferous era. The 'yellow band series' also appears on the north face of Lhotse and Nuptse in the so-called Cwm. It climbs steeply up the south face of Lhotse, folded and beset with faults.

As distinct from the Cwm, the latter phenomena must be ascribed to the transverse structures. On the whole we find a complicated overlapping of different structures. A great frontal fold is to be observed on the south face of Lhotse and especially further to the east.

Odell defined the northward dipping limestone on the north *arête* of Everest as permocarbiniferous. In 1924 he quite rightly propounded the theory of overthrusting of the upper Everest series.

Any further interpretation, based on the view from the south, runs up against difficulties, particularly where the strike of the west-east structures is concerned. Lombard excluded the Nuptse fold, as this fold with its granite is overthrust above the next lowest series (my Makalu fold).

The east face of Everest-Lhotse down to the Kangchung Glacier is an example of a very good outcrop. The frontal fold of Lhotse is the schist envelope of the Nuptse fold around its granite (Fig. 14). The Nuptse nappe roots deep down and is overlaid by a higher fold, the Everest overthrust. The base of its thrust plane runs across the South Col. Small structures stretching backwards adjoin the Everest overthrust on the north. (This is shown by the rock and glacier hatching in Erwin Schneider's map; 1.5 kilometres north-east of Everest summit.)

Everest also shows a synclinal structure in longitudinal profile. It is only just evident in the sediments a little to the north of the summit but down below it is much more definite. The crystalline trough of the synclines appears in the Kangchung basin owing to an axial uplift of this syncline towards the east (towards the Arun!). It widens considerably in an easterly direction and the back-folding also increases on the northern flank.

My own expedition through the Khumbu Valley to the foot of Everest ended at about 6000 m. at the south ridge of Pumo Ri. As I was alone I was naturally averse to attempt the ascent of high peaks, which can only be climbed successfully by placing several high camps on glaciers. Only on a few exceptional and unavoidable occasions did I undertake a two-man expedition together with my trusty Sherpa, Aila. In such cases we had to carry our tents, food, mountaineering equipment, etc., on our backs. This occurred, for example, in exploring the south side of Shisha Pangma when our route led over the long Langtang Glacier. Whenever possible I preferred to place my last camp as high as possible accompanied by my men and then push on with a single Sherpa and without loads by a forced march through the night in order to get as high as possible. In this manner I made a dozen or so first ascents of 6000-m. peaks which were important for my geological research.

It is not always necessary for a geologist to climb the high peaks. He occasionally sees better cross-sections in the deep valleys and in most cases the geological strata of the summits strike and dip down into the valleys where they are plainly visible and can be examined on the spot.

We must now go back a little in time in our narration. My exploration of the narrower confines of the Everest region did not take place during the expedition described in this section, but a year earlier. Moreover the season was well advanced, for I began the journey from Kathmandu after the rainy season, with diversions into all the valleys right up to the Tibetan frontier.

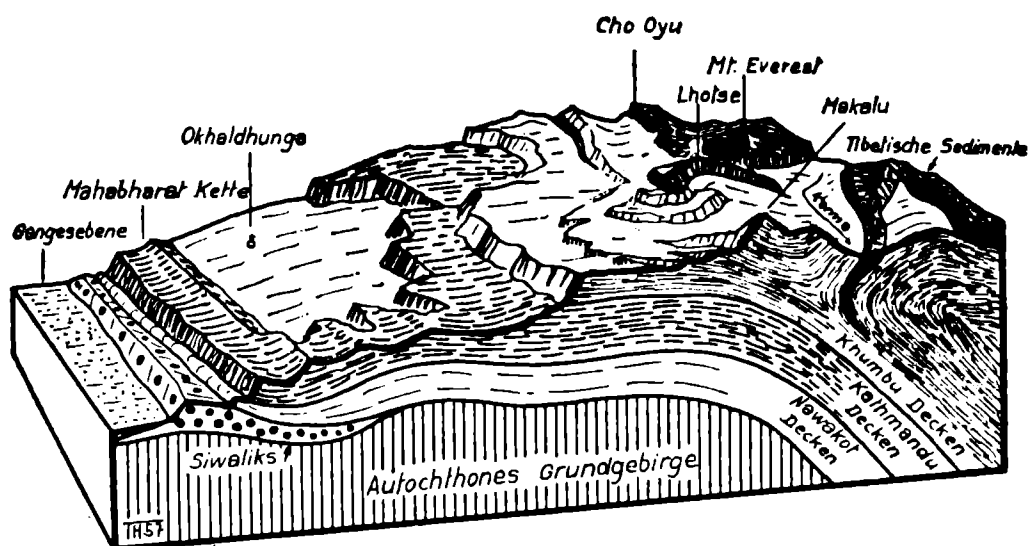


FIG. 24. Graphic block diagram. Representation of the Everest group.

In consequence we did not reach Thami, the first village in the Khumbu Valley, until the beginning of November. Thami was the home village of my Sherpa Aila and I naturally had to stay for some days as an honoured guest in his own fine house and those of his relations. I took up my abode in the adjoining private temple, among beautiful wood carvings and paintings. Much *chang* (home-brewed beer) was consumed and the evenings spent at the fireside of my hospitable friends remain among my most pleasant recollections. Needless to say several valuable days were lost owing to the advanced season. The morale of my otherwise excellent porters from the Kathmandu Valley was a little shaken owing to our experience on the Tesi Lapcha, and also the bitter weather which we encountered on our journey to the Nangpa La. I was therefore obliged to leave them behind in Thyangboche and replace them by local Sherpa herdsmen. It was therefore not until 23 November, after a trip into the Imja basin, that I was able to set up my base camp on the Khumbu Glacier at the same place chosen by all the large mountaineering expeditions. Having done this we continued on our way.

The last night in Base Camp on the Khumbu Glacier was extraordinarily cold and we waited impatiently for the morning sun, for in the daytime the weather was usually fairly warm. However, the north-west storm which was raging on the summits after the monsoon descended lower every day. When Aila and I left Base Camp (5200 m.) it was dead calm but 200 m. higher, near the south *arête* of Pumo Ri, a strong nor'wester set in, gradually increasing to hurricane force. It was only with the greatest difficulty that we were able to proceed at all and we had frequently to hold on to rocks in order to stay upright. The air temperature during the storm

was not low, in fact it was considerably higher than at night much lower down. The storm was similar to the onset of *föhn* in the Alps. Like the *föhn* the north-west storm over the Himalayas was a katabatic wind on the south side which in descending increased in temperature. The geological work undertaken on a good view-point at 6000 m. was a veritable torture. The howling gale almost took one's breath away; apart from the plume on the summit of Everest, there was not a cloud in sight. As I looked at the nearby black-looking rocks of Everest free from snow, I could not refrain from thinking about the great achievement of the men who had climbed it. Above the gap of the Lho La could be seen the summit of Changtse (North Peak, 7537 m.) which is situated to the north of the well-known North Col. I also thought about those men who, thirty years ago, attempted Chomo-lungma from the north after a month's march through completely unknown territory in Tibet, under most unfavourable conditions, without oxygen and supplied with equipment which, when compared to that of modern days, could only be described as primitive. Their courage and pioneering spirit was paid for with their lives on some occasions.

A final climb on the following day was made to a height of 5100 m. on the spur to the north of Samso Chopo on the south-east ridge of Taboche. The magnificent view over the Imja and Khumbu basins enabled me to tie up the geological data which I had obtained on the previous climbs. At this point the storm was somewhat less violent as we were sheltered by Taboche. A welter of savage peaks and immense rock walls lay around. The granite mass of Makalu (8470 m.) raised its head above the gap to the north of Baruntse, and the panorama extended as far as the Mittelland which was covered by a seething mass of cloud at about 3600 m. Its clammy fingers were reaching down towards the village of Namche Bazar.

While I was busy with my geological work, Aila was looking at the view through my field-glasses. This struck me as unusual for he was not in the habit of using binoculars. When I asked him what he was looking at, he replied without looking up, 'Looking Yeti, sir.' This made me start. He went on, 'Now very good season for Yeti, sir; now Yeti very hungry, now Yeti eating man.'

He pointed to a group of herdsmen's huts at Samso Ogma just below us and told me with a serious face that three years ago the Yeti had eaten two men during the night. No, he had not been there himself, but a cousin had told him. I then asked him whether he had got the pistol with him. 'No, sir,' he said, 'down with the luggage!' He continued to recite further horror stories while he searched the country with the binoculars. I had heard all these stories before; when we were in Thami they told me about adventures with Yetis complete with all the details

one could wish for. For example, one night Yetis came into the village and started to remove the roof of a house as all the doors and windows were firmly secured. They were finally driven off by the inhabitants making a terrific row with drums and trumpets from the temple.

I had long wished to see a Yeti. Every night in the camps in the Khumbu Valley I had my two cameras ready and my flashlight apparatus set. I only considered my pistol as a means of defence if I were attacked. The thought of encountering a Yeti, which from all accounts is an aggressive beast, alone and unarmed, was somewhat disturbing. Night was drawing on and it would almost certainly be dark before we could reach the highest village.

I must admit, on careful consideration, that unfortunately I was unlikely to see a Yeti, for all the stories, however full of detail they might be and told in the first person, were only second- or third-hand. If one probed deeper and asked the story-teller if he himself had seen the Yeti, it was always his uncle who died some years ago, or his brother who lived on the other side of the mountains, *and* moreover had been away in Tibet on business for the last couple of years. There was not a single person in the whole of Khumbu—and this was confirmed by other reliable explorers—who had ever seen a Yeti. Once when I came upon strange footprints on a glacier near Annapurna and asked Aila what they were, he replied without hesitation, 'This is the Yeti, sir.' When I asked him how he knew, he said, 'Nobody else here, sir,' as if that clinched the matter. And this was about the only proof available for most of the Yeti stories!

The Khumbu Valley must be regarded as the fount of all Yeti stories. The mysterious footprints, which I had seen there myself and which could not be identified with any other print, have so far not come to light elsewhere. It must, however, be admitted that superstition and belief in demons have made the Yeti stories even more sensational than they really are.

Up to the present it is not exactly known what a Yeti is. Even the drawing which I saw on the walls of the Monastery of Thyangboche gave no indication. It was a sort of allegorical picture, a cross between a bear, a wolf and a panther.

There is, however, little doubt that some living creature left the footprints. In my opinion they do not exist in these inhospitable heights, but rather in the far-off impenetrable primeval forests in the lateral valleys of the Arun, south of Makalu and Chamlang. They only occasionally cross a glacier when moving from one valley to another. There exists no proof that we are dealing with an anthropomorphous creature—the snowman, the long sought-after missing link from the prehistory of mankind. I have seen long-haired apes at 3700 m., bears at 4100 m., and snow leopards at 5100 m. (on the Kangchenjunga Glacier).

Whatever they may be, I find it quite thrilling that man, who has set out to conquer the universe, should still find such absorbing problems on earth.

Towards evening, as Aila and I went down to the valley and watched the steel-blue shadows grow with the summits shining in the gold of the sunset, I was overcome by a feeling of melancholy. In all probability I would never again be so close to the greatest mountains on earth. Never again perhaps should I feel the 'spirit' of the mountain-building force as at this moment.

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2

THE MOUNTAIN EXPLORATION OF THE EVEREST MASSIF

G. O. Dybrenfurth

The highest mountain in the world was 'discovered' in 1852. Whether this honour falls to the Head of the Computing Office of the Survey of India at that time, Radhanath Sikhdar, or to his younger assistant, Hennessy, is now beside the point. At all events the Surveyor General, Sir Andrew Waugh, was informed that 'Peak 15' was higher than any other previously surveyed. In 1856 this peak was named Mount Everest, after Sir George Everest, the Head of the Survey of India from 1823 to 1843. The old Tibetan name Chomo-lungma, or Chomolongma,¹ was not known until much later.²

The official height was given as 29,002 ft. (8840 m.) and remained so for a hundred years though it was repeatedly contested. The latest height as determined by the Survey of India (1952-55) was fixed at 29,028 ft. (8848 m.) $\pm$ 0.8 feet.³ (In the *Himalayan Journal* reference, Gulatee suggests $\pm$ 10 feet rather than 0.8 feet, which was the Survey figure.)

To climb the highest mountain on earth has always been the dream of every true mountaineer. Nobody knows who first had thoughts of climbing Everest; all that we know is that Charles G. Bruce made an attempt in 1893 and that Bruce, T. G. Longstaff and A. L. Mumm made preparations for an Everest expedition in 1907 which came to nothing. The political difficulties were too great, for both Tibet and Nepal were closed to foreigners. Nothing could be done in this way before the end of the First World War.

I. THE FIRST ATTEMPTS FROM THE TIBETAN SIDE

All attempts from 1921 to 1939 were from the northern, Tibetan side and were almost exclusively British. This is so well known that we will content ourselves with a short tabulated résumé.

¹ Sir Charles Bell advocated *Cha-me-lung*, the name given in the permit from the Dalai Lama in December 1920. However, the name here obviously refers to the district and not the mountain and means 'Bird Land'.

² See note on Tibetan place-names p.ix.

³ B. L. Gulatee (Director of Geodetic and Research Branch of the Survey of India): The Height of Mount Everest. *Him. Jour.* Vol. 19, 1955-56, pp. 174-5.

1921 The first Everest Expedition was led by Charles K. Howard-Bury. Two officers of the Survey of India, H. T. Morshead and E. O. Wheeler, produced, in about three months, a map of 40,000 square kilometres (about the area of Switzerland), which is still in use today. Mountain reconnaissance was largely undertaken by G. H. Mallory and C. H. Bullock, who after many detours found a way to the Chang La, 6985 m. This 'North Col' formed the mountain base for all attempts on Everest for a quarter of a century.

1922 Leader, General C. G. Bruce. Base Camp (5040 m.) at the end of the Rongbuk Glacier, Camp 1. (5480 m.), 2 (5930 m.) and 3 (6400 m.) on East Rongbuk Glacier, 4 (6975 m.) just below the North Col. From Camp 5 (7600 m.) G. H. L. Mallory, E. F. Norton and T. H. Somervell climbed up to 8170 m., about 200 m. below the shoulder on the north-east ridge. The time taken for 600 vertical metres was $6\frac{1}{2}$ hours, without oxygen. Second attempt by G. I. Finch with Geoffrey Bruce and Tedjibir Bura. Both the British reached a height of 8326 m., using oxygen this time. At the third attempt, at the beginning of June, seven Sherpas were killed by an avalanche on the steep slopes below the North Col.

1924 General Bruce was intended to be the leader of the third expedition, but had to hand over to his deputy, E. F. Norton, because of illness. This was the largest of all Everest expeditions; in fact it was over-organized, for 350 porters were required to transport the equipment through Tibet, a very costly operation. Base Camp was reached at the end of April. May was bad, and wintry conditions made many Sahibs and Sherpas unfit, forcing two retreats from the high camps. Camps 1 to 4 were not re-occupied until the end of the month; Camp 5 was established on 1 June and on 3 June Camp 6 was set up at 8145 m. It was from here that Norton and Somervell made their celebrated assault on 4 June without oxygen. The latter had to give up at 8540 m. owing to 'high altitude throat'. Norton struggled on over the 'yellow slabs' as far as the west side of the Great Couloir. It took him an hour to cover a horizontal distance of 270 m. and a vertical height of only 32 m. Nevertheless this was a remarkable achievement and this record height of 8572 m. was not exceeded until 1953, and then only with the help of oxygen.

On 7 June Mallory and A. Irvine reached Camp 6 (8145 m.) while N. E. Odell, the geologist who remained behind as support on the North Col went on alone without difficulty to Camp 5 and spent the night there. Mallory and Irvine left Camp 6 on 8 June for the final attack on the summit. They used oxygen and went along the top of the north-east ridge instead of the yellow bands of the Norton traverse. Odell, who





PLATE 20. The Kangchung side of the Everest massif. The highest peak is Mount Everest, 8848 m. To the left is the South Col, 7986 m., followed by Lhotse, 8501 and Pethangtse, 6724 m. (partially hidden). The Chomo Lonzo Glacier flows in from the left, its snout has impinged upon the opposing valley flank, causing a rock fall. The fact that in a pre-contemporary glacial advance (1860?) a lateral glacier has sealed off the main valley is a frequent occurrence in the Himalayas. In the foreground are Buddhist tombs

went slowly on to Camp 6 the same day, thought he saw them for an instant through the mist, at about 12.50. But the clouds gathered again and from that moment nothing more was ever seen of Mallory and Irvine.

Nine years later a Valaisan ice-axe was found at 8450 m. It is possible that the oxygen gave out, or perhaps Irvine slipped on the steep slabs, dragging the very experienced Mallory with him to destruction. Nobody will ever know.

1933 Hugh Ruttledge was the leader on this occasion. Base Camp and Camps 1 to 4 were set up at the same places but Camp 5 was advanced to 7833 m. and Camp 6, the highest of all, to 8350 m.

On 30 May P. Wyn Harris and the geologist, L. R. Wager, made a reconnaissance along the north-east ridge, where they came across the ice-axe which had belonged to either Mallory or Irvine. They formed the opinion that the ridge was technically impracticable, particularly at the 'second step'. They then turned their attention to the bands on the north-west flank but got no farther than Norton in 1924, being forced to retreat owing to exhaustion and lack of time. On 31 May it was snowing hard, but on 1 June Frank S. Smythe and Eric E. Shipton started off on a second attempt. Owing to stomach trouble Shipton had to give up but Smythe went on alone and about ten o'clock had reached approximately the same place as Harris and Wager had done nine years before. He had time in hand on this occasion, but new snow had made conditions so bad that Smythe considered it too dangerous to go on alone and came down. Shortly after this the monsoon broke and the fourth British Everest expedition was broken off.

The same year saw the Houston Mount Everest Expedition, which consisted in two flights over the summit. A large number of excellent photographs and films were taken.

1934 A complete contrast from the former large expeditions was the solo attempt by Maurice Wilson. He left Darjeeling at the end of March, disguised as a Tibetan and accompanied by three Sherpas and a pony which carried all his equipment. He reached the Rongbuk Monastery after a series of forced marches. Having reached Camp 3 the Sherpas, quite understandably, refused to follow him up to the North Col. In point of fact they had not taken him seriously. He set off alone and made three unsuccessful attempts to get there, as he wrote in his diary. His body was found in 1935, close to Camp 3. He had died of cold and exhaustion.

1935 Permission from the Dalai Lama was so late in arriving that it was considered impossible to organize a large expedition in the time available. As, however, the permit was from June 1935 to June 1936, it was decided to make the attempt in 1936 and use 1935 for a reconnaissance. Leadership of this reconnaissance was entrusted to Eric Shipton and he was accompanied by the following: H. W. Tilman, the New Zealander, L. V. Bryant, the British climbers E. Kempson and E. H. L. Wigram, Dr. Charles Warren, expedition doctor, and the topographer Michael Spender. The party left Darjeeling on 24 May with fifteen of the best available high-altitude porters.

Instead of going straight to Everest, Shipton spent several weeks of fine weather on the Nyönno Ri (6748 m.) a little-known range about forty-five miles east-north-east of Everest without, however, reaching the summit. They did not reach the Rongbuk Glacier until 4 July where, to their astonishment, they found the north face of Everest entirely free from snow. Conditions were excellent and by 12 July they had established Camp 4 on the North Col (6985 m.). But time had run out and the monsoon, which was actually a month late, broke in full force. They waited for three days and then beat a retreat; lucky to be able to descend in the track of a huge avalanche which had swept the north-east slopes of the mountain, reaching the East Rongbuk Glacier in safety. If they had only been at the North Col two weeks earlier, Everest might have been climbed in 1935. There was nothing to do but climb elsewhere and the party split up into small groups.

Three 7000-m. peaks were climbed. Khartaphu (7221 m., 23,640 ft.), 'Kellas Rock Peak' (7065 m., 23,180 ft.), and Kharta Changri (7032 m., 23,071 ft.). An attempt was also made on Changtse (north peak, 7537 m., 24,730 ft.), which lies close to the North Col and which is still unclimbed but snow conditions made any progress on this peak impossible. More success was achieved with the smaller peaks (6000 m.), of which no less than twenty were climbed.

More important than these successes were the photographic achievements, particularly the stereo-photogrammetric photographs taken by Michael Spender which formed the basis of a new map of the north face of Everest. Thus, we owe to the 1921 and 1935 reconnaissances our knowledge of the Tibetan side of the Everest Range.

Shipton had always advocated small expeditions and events had proved him right. Feeding off the land considerably reduced the number of loads to be carried and had also the advantage of cheapness. However, the commissariat chiefly consisted of mutton, rancid butter, and eggs; and a daily diet of twenty to thirty or even thirty-five not always fresh eggs per day was not, in Shipton's opinion, suitable for every stomach.

1936 The sixth Everest Expedition again under the leadership of Hugh Ruttledge was a complete failure, in spite of first-class organization; for this year the first snow occurred at the end of April and by 18 May there were two feet of new snow on the North Col. Temporary improvements in the weather were utilized for attempts on the mountain. On one of these occasions, Shipton and Wyn Harris were caught in a windslab avalanche and were lucky to escape with their lives. The monsoon arrived three or four weeks earlier than usual and the expedition was abandoned without ever having any real prospect of success.

1938 This seventh Everest Expedition, led by H. W. Tilman, consisted of a small but very strong and experienced team, having the following members: E. Shipton, F. S. Smythe, N. E. Odell, C. B. M. Warren, Peter Lloyd and P. R. Oliver, the only 'new boy'. As it was agreed to cut out as many luxuries as possible, the cost was reduced to about £600 per person. Tilman was just the right leader for a spartan organization of this nature; he always relied on pemmican and rejected the idea of tinned foods to vary the expedition's diet.

The party was in Rongbuk by 6 April. The north face of Everest was completely free of snow and conditions seemed excellent. The weather was, however, still wintry and very cold, so there was no urgent hurry and Camp 3 was not occupied until 26 April. It was not yet thought necessary to prepare a route up to the North Col, as nearly everybody was suffering from chills and sore throats. The party, therefore, crossed the Lhapka La (6766 m.), descended the Kharta Valley, and set up a 'recuperation camp' at the junction of this valley with the Arun Gorge at a height of only 3400 m. In this manner the whole of the time gained was frittered away, when it could have been devoted to scientific work; Odell, for example, was just the man for geological research but the 'notoriously anti-scientific leader' made light of such 'goings-on' and frowned upon any scientific pursuits or even forbade them altogether.

Suddenly it was too late. Snow began to fall on 5 May, and the expected period of pre-monsoon fine weather never arrived; it was 1936 all over again. In spite of this, desperate attempts were made. After much exertion Camp 5 was set up at 7864 m. (25,800 ft.) on 6 June and Camp 6 on 8 June on a patch of scree at 8291 m. (27,200 ft.). The assault was mounted on 9 and 11 June but, bogged down in deep snow, even the new oxygen equipment was of no avail.

The somewhat meagre result of this expedition was a traverse of the North Col from the East Rongbuk to the Main Rongbuk Glacier.

The campaign was now interrupted by the Second World War, during which time the only activity consisted of three flights over the mountain.

1942 Robert L. Scott, an American Air Force Officer, while testing a new fighter, made a flight from Assam over Kangchenjunga, Makalu, Lhotse and Everest.

1945 On 16 June a New Zealander, C. D. Andrews, accompanied by C. Fenwick, an Englishman, flew over the mountain in bad weather from Alipore, near Calcutta.

1947 On 27 March Kenneth Neame, a twenty-one-year-old pilot of the R.A.F., flew over the area from Dum Dum in his Spitfire and took some very interesting pictures with his Leica camera.

Compared with the carefully prepared Houston Mount Everest flight of 1933, these service flights can only be considered as bold but hastily improvised adventures. However, their photographic value should not be underestimated although the results could not be published until later.

The year 1947 saw another solo attempt, by a Canadian, E. L. Denman. Disguised as a Tibetan he set off with two Sherpas from Darjeeling to Rongbuk via Gangtok and later left for the North Col. He admits that he had not enough food with him and did not even take a sleeping-bag. Although he never reached the North Col (6985 m.), he claims to have attained a height of 7160 m., which was obviously an error. Five weeks later he was back in Darjeeling. An 'expedition' of this nature cannot be taken seriously.

2. RECONNAISSANCE AND FIRST ATTEMPTS FROM THE NEPAL SIDE

1950 The south side of Everest had always been wrapped in mystery, for Nepal was closed to the western world until 1949. In the autumn of 1950, Tilman joined a small American expedition organized by Houston and his son. The march out from Jogbani, Indian railhead, to Khumbu, little known at that time, has now become a well-trodden way of approach and the last inhabited area, the splendidly situated monastery of Thyangboche, is now world famous.

Tilman and Dr. Charles Houston set off for the Khumbu Glacier, lying to the north, but were not able to reconnoitre its actual source, the Western Basin, now known as the Western Cwm. For this reason they had no actual data upon which to base an opinion as to a possible successful ascent of the mountain from this side. Barely five weeks later they were back at Biratnagar, close to Jogbani.

1951 Another solo attempt took place this year, a Dane this time, Klaus Becker-Larsen, who chose Everest for his first essay in mountaineering.

In twenty-three days he rushed from Darjeeling to Namche Bazar with four Sherpas. An advance to the Khumbu Glacier was soon abandoned and instead they went down the Bhote Kosi Valley and crossed the easy Nangpa La (5500 m.) to the Rongbuk Monastery, without a permit to enter Tibet, in the rapid time of six days. As might be expected, the 'attack on Everest' did not get as far as the North Col; at this point the porters refused to continue and the party made its way back to Darjeeling by the same route.

Becker-Larsen's attempt was an astonishing *tour de force* but that was all. The combination of an approach from Nepal with an attempt on the mountain from the forbidden Tibetan side is of interest, but not to be recommended for future expeditions.

The Himalayan Committee jointly formed by the Alpine Club and the Royal Geographical Society prepared a fresh expedition for the spring of 1951 with the object of exploring the West Basin and finally investigating the possibility of an ascent of the mountain from the Nepal side. The party consisted of Eric Shipton, leader; T. D. Bourdillon, W. H. Murray and Dr. M. P. Ward. Two New Zealanders, E. P. Hillary and H. E. Riddiford, later joined the party.

Base Camp was set up in the upper Khumbu Valley on 29 September. During the next few days the icefall of the Khumbu Glacier was reconnoitred but no way through was found and the party was lucky to escape an avalanche without loss of life. Shipton thereupon decided to bide his time until the monsoon snow had hardened and in order to make the most of the pause, split up the party into two groups. Hillary and Shipton went off to the south-east to explore the Imja Basin and the Amphu Labtsa (5780 m.) -Hongu Khola range between Hongu and Barun. The rest of the party explored the terrain lying to the west of the Khumbu Glacier: Changri Glacier-Changri La, Guanara Glacier-Ngojumba Glacier-Dudh Kosi.

When they were re-united, they made another attempt on the great icefall below the Western Cwm. On 28 October they finally fought a way up and stood at the threshold of the west basin, but further progress was barred by a huge crevasse which stretched right across the glacier from Nuptse to the west ridge of Everest. As it seemed impossible to circumvent it, Shipton called a retreat. This was a painful decision in view of the fact that they were now convinced that there was a practicable route from the Western Cwm to the summit of Everest via the South Col.

In November the party turned their attention to the terrain west of the Bhote Kosi, the Rolwaling Himal, the best-known peak of which is Gaurishankar, 7145 m. (23,440 ft.). The highest peak in the range, however, is the recently discovered Menlungtse, 7181 m. (23,560 ft.). On the

west side of the Menlung La (about 5900 m.) they came upon fresh tracks of the Yeti, the Abominable Snowman. Shipton's account of this find and his photographs are well known. The party returned to Kathmandu on 21 November. It was undoubtedly a successful reconnaissance.

1952 This year it was the turn of the Swiss, who had for long been aspiring to Everest. The leader of the spring expedition was Dr. Edouard Wyss-Dunant, of Geneva, and Dr. Gabriel Chevalley of Bex was the expedition's medical officer. The leader of the climbing party was Rene Dittert of Geneva. The other climbers, all from Geneva, were Jean-Jacques Asper, René Aubert, Léon Flory, Ernst Hofstetter, Raymond Lambert, and André Roch. The scientific party consisted of Professor Augustin Lombard, geologist, Albert Zimmermann, botanist, and Marguerite Lobsiger-Dellenbach, ethnographer. Unfortunately the party did not include topographers or cartographers.

They left Kathmandu on 29 March, with 165 porters and 20 Sherpas under Sirdar Tenzing, and reached the foot of the Khumbu icefall on 25 April. The great transverse crevasse, which had held up the Shipton party in 1951, was crossed after some difficult ice work. Asper, the youngest member of the party, was the hero of the day. The crevasse was spanned by an airy rope bridge, which served to carry men and loads.

The Western Cwm is a glacier basin about two and a quarter miles long and Camp 4 (6400 m.) was established in it as Advanced Base Camp. On 12 May a further camp, Camp 5, was erected at the foot of the Lhotse face at the back of the Cwm, at 6800 m. The fight for the South Col was on. Just to the right of the Col, a rock ridge led upwards, nicknamed the 'Geneva Spur'. It was flanked on both sides by steep ice couloirs, exposed to avalanches from new snow. The right (southern) couloir was furnished with fixed ropes and a depot was established on the Spur itself at about 7400 m.

On 25 May an attempt was made to reach the South Col (7986 m.) from Camp 5 in one day, but it was found impossible to negotiate the 1200 m. without oxygen and with fairly heavy loads. It was found necessary to set up a precarious emergency camp at about 7800 m. and the Col, between Everest and Lhotse, was not reached until midday the next day.

Four men set off for the south-east ridge of Everest on 27 May and found a site for Camp 7 at about 8230 m., according to Erwin Schneider's new photogrammetric map (1:250,000). This 'camp' was really only an emergency bivouac, as there was only room for a single tent. There were no sleeping-bags nor even a cooker. Nevertheless Tenzing suggested that one rope should stay and make a dash for the summit next day. Aubert

and Flory agreed and descended to Camp 6 on the South Col, while Lambert and Tenzing remained.

It was a brave decision but had no chance of success. Next morning, after a bad night, they climbed up to about 8500 m. but the oxygen equipment, which had not been sufficiently tested, was deficient in supply so they were only able to ascend about 40 m. in the last hour. The weather was then deteriorating rapidly and they had to turn back at 1.30 p.m. They were so exhausted by the time they reached the South Col they had to be carried into the tents by their friends.

On their way down to Camp 5 on 29 May they met the second party on the way up for a final attempt. They only got as far as the Col where they were storm-bound for three days before being forced to retreat. The entire party, including the scientific members, were all down in Namche Bazar on 9 June when the monsoon broke.

Another attempt was made at the end of the monsoon and many changes were made in the team for this autumn expedition. The Swiss Foundation for Alpine Research in Zürich appointed Dr. G. Chevalley as leader, and Raymond Lambert took charge of the climbing party in place of Dittert who had to return home. The climbing party consisted of Ernst Reiss, Arthur Spöhel, Gustave Gross, and Jean Buzio. The American-Swiss, Norman G. Dyhrenfurth (a son of G. O. Dyhrenfurth) was film and camera man.

This time a log bridge was built up to a veritable strong point. In the spring the snow conditions on the Geneva Spur had been favourable but now, in October, everything was a sheet of ice. In spite of this Lambert still kept to his old route, which turned out to be a disastrous mistake. It was intended to cut a series of good steps up the couloir from the *bergschrund* to the rocks of the Spur, supplied with a fixed rope attached to pitons. After several days of hard work, a considerable part of the staircase had been prepared when on 31 October an ice avalanche swept down the couloir on to the ascending party. The avalanche had come from the Lhotse funnel, high up on the face and the cascading blocks of ice struck one of the Sherpas, Mingma Dorji, killing him and injuring several others. Completely unmanned by this accident, a rope of three Sherpas, rather badly placed just below the *bergschrund*, slipped and shot down 600 feet into a gully. They were only slightly injured but it was enough to put them out of action for the rest of the expedition.

This 'Black Friday' was a severe blow for the expedition. Mingma Dorji was buried in the moraine near Camp 4. The Sherpas were somewhat demoralized and the supply organization had to be reorganized. A considerable amount of valuable time was lost and a new route had to be made up the Lhotse Glacier to the south, on which Camp 6 (7100 m.)

and Camp 7 (7400 m.) were established. And now the mountain began to defend itself with its most potent weapons, bitter cold, and storms. At last the South Col was reached on 19 November where the autumn Camp 8 was established at 7986 m. Nobody was thinking seriously of victory any longer. When Lambert, Reiss, and Tenzing tried to ascend towards the south-east *arête*, a hurricane burst upon them at about 8150 m. and the cold was so intense that it would have been suicide to have gone on. The retreat was on; once more the mountain had won.

The same year, 1952, another expedition was operating in Khumbu, this time a British effort. It was led by Shipton and had for its objective Cho Oyu (8153 m.). A further aim of the expedition was to try out improved oxygen and other equipment with a view to the next British attack on Everest. The party consisted of Tom Bourdillon, R. Colledge, R. C. Evans, A. Gregory, Campbell Secord, the physiologist Griffith Pugh, and the three New Zealanders, Edmund Hillary, George Lowe and Earle Riddiford.

Evans and Gregory were soon convinced that the south face of the Cho Oyu range was unclimbable. They rejoined Shipton's main party at Lunak. At the same time Hillary and Lowe had climbed a peak of about 6430 m. to the west face of Cho Oyu. Their report confirmed what W. H. Murray had noted during his reconnaissance of 1951: the mountain appeared accessible from this side, the only doubtful pitch being a steep ice step. It was precisely this ice barrier at 6800 m. which stopped the British party on 10 May 1952. Shipton got cold feet about the Chinese situation and had second thoughts about organizing an efficient supply system suitable for an assault on an 8000-m. peak so close to the Tibetan frontier. Moreover, most of the climbing party were in poor health so the attack was called off and Cho Oyu, 'the easy eight-thousander', remained inviolate.

Hillary and Lowe, the only two who were really fit, found themselves a consolation prize by climbing Palung Peak, a 22,600-ft. mountain to the north-west of Cho Oyu. They returned to Lunak on 16 May and the expedition now split into three groups:

1. Bourdillon, Colledge, Secord, and Pugh camped for a week on the Menlung La (5900 m.) and carried out experiments with and without oxygen gear. During this period they climbed Pangbuk Peak to the south of the pass.
2. Hillary and Lowe returned to Namche to restock. They then went up the Dudh Kosi Valley to the Ngojumba Glacier, forced a way through the difficult icefall below the Nup La (5915 m.), crossed this pass for the first time, and advanced into Tibet as far as the East Rongbuk Glacier. They

were not, however, able to climb Changtse (7537 m.) as they had intended. 3. Shipton, Evans, and Gregory explored the terrain of Lunak: the Pangbuk Basin, Langmoche Khola, Tesi Lapcha (5821 m.), and the Tolam-Bau Glacier, where they climbed a peak of about 6350 m. Towards the end of May they returned over the Tesi Lapcha to Thami.

The main party returned to England, while Shipton, Evans, Hillary, and Lowe continued the exploration of the Barun Glacier begun in 1951. From the Imja Basin they crossed the Amphu La (5750 m., 18,963 ft. according to Schneider's map), a none too easy pass, and descended to the upper and largest of the five Hongu Lakes. The col between Hongu and the Barun Valley actually consists of two passes, with a high level glacier in between, from which they climbed several 6000-m. snow peaks.

The lower part of the Barun Khola, just before it joins the Arun Valley, is a deep gorge filled with impenetrable jamboo jungle, so that an exit must be sought over a fairly high pass to the Kasua Khola.

3. EVEREST CLIMBED

1953 The new British Everest Expedition was prepared with the greatest attention to detail. The leader was Colonel John Hunt, a first-rate climber with considerable experience of the Himalayas. He was, moreover, a Colonel at the Staff College and as such was used to military precision which he also demanded of his colleagues. The party consisted of the following members: George Band, Tom Bourdillon, Dr. Charles Evans, Alfred Gregory, the two New Zealanders Edmund P. Hillary and George Lowe, James Morris (*The Times* correspondent), Wilfred Noyce, Griffith Pugh, physiologist, Tom Stobart, camera man, Dr. Michael Westmacott and Charles Wylie. Tenzing joined the party as climber and Sirdar. It was a large and very strong expedition, most members of which had some Himalayan experience.

The most important articles of the equipment were as follows: an aluminium alloy ladder made up in sections, for bridging large crevasses, rope ladders, a 2-inch mortar for shooting down avalanches, radio sets, cold-weather protective clothing of the latest type, primus cookers for use at high altitudes, and two different types of oxygen apparatus:

Type 1. Closed circuit system excluded the outside air. The oxygen exhaled by the wearer is used again. This system is very economical to operate but the increased resistance to breathing is unpleasant.

Type 2. Open circuit system. This system had been in use for a long time, but the sets used in 1953 were considerably improved.

It was of immense importance that sufficient time should be allowed for

thorough training, acclimatization, and practice with the different sets, so that during this period, in spite of the earliness of the season, not only 5000- but 6000-m. peaks were climbed. The best Sherpas were also tried out with oxygen.

The camps were set up at about the same places as in the Swiss expeditions of 1952 and the route up to the South Col was that chosen by the Swiss in their autumn attempt, namely via the Lhotse Glacier on which were sited Camps 5, 6 and 7. Finally Camp 8 was established on the South Col at 7986 m. and stocked with everything necessary for a push to the summit. Nine of the eleven British reached the South Col, three of them on two occasions. Out of twenty-five porters, nineteen carried loads of from 30 to 40 lb. up to the Col; six of them went there twice. This was a resounding success for the training and acclimatization—and for the oxygen.

Hillary and Tenzing, both in first-class condition, formed the strongest rope, so that Hunt chose them for the final assault. The highest Swiss camp of May 1952 (8230 m.) was not high enough, so it was necessary to put Camp 9 even higher. As only one Sherpa, Ang Nyima, was fit for work, Lowe and Gregory acted as porters. The three men, as well as Hillary and Tenzing, carried loads of up to 60 lb.—an astonishing performance at this altitude and quite impossible without the use of oxygen.

At about 8500 m. they found a fairly satisfactory site for a bivouac, on the left side of the ridge below a large rock. Lowe, Gregory and Ang Nyima laid down their loads and, although very tired, immediately started down so as not to waste any time.

With some effort, Hillary and Tenzing contrived to clear two small platforms, set at an angle of 30 degrees, for their last night before the bid for the summit. The tent was erected over these ledges and firmly tied down. All this work was done without the use of oxygen, as they had none to spare.

When Hillary made a tally of the oxygen supply, he found to his alarm that there was less available than he had expected. Fortunately, Evans and Bourdillon had left two partly-full bottles of oxygen below the South Summit on the day before, which would do as a last reserve.

They were able to have a reasonably good night as they had plenty of food, lots of sweet drinks, and used a reduced flow of oxygen for sleeping purposes. Gradually the wind dropped and it became very cold (-27° C.) and as long as the oxygen lasted they felt well and even slept a little. When they were obliged to cut off the supply (1 litre per minute) they felt cold and miserable.

They were ready to start at 6.30 a.m. They put on their oxygen sets, weighing 30 lb., and set off. They felt a little happier when they passed

the two oxygen bottles left by Evans and Bourdillon. At 9 a.m. the South Summit was reached where they dumped two empty cylinders, which had only been two-thirds full when they broke camp. Now they had one full bottle each, containing 800 litres, which at a rate of flow of three litres per minute would last them for four and a half hours. Feeling much relieved by the reduction in the load—they were now only carrying about 20 lb. each—Hillary and Tenzing left the South Summit and started along the *arête* towards the summit of the mountain.

At a tricky spot, Hillary, who was usually leading, realized that Tenzing was breathing with difficulty. A quick check of his set showed that the exhaust pipe, about two inches long, was completely iced up. Hillary soon cleared it and also his own and then the climb was resumed.

The weather was fine, that is to say as fine as it ever is on the top of Everest. They were protected against the cold by the special clothing designed for the purpose and the wind, which drove fine snow before it, was negligible. In about an hour they came to the foot of a rock step, some forty feet in height, which Hillary climbed with considerable difficulty. After a slight rest at the top of this formidable pitch, he brought up Tenzing on a tight rope and he in his turn collapsed with exhaustion.

The ridge continued as before, huge cornices to the right and steep slopes on the left as Hillary hacked step after step. Crampons were no use here, the slope was too steep and the balance too tricky. At last even the tough Hillary began to tire and Tenzing behind him was only moving very slowly. Suddenly they saw the East Rongbuk Glacier, the ridge dropped sharply away, another couple of steps with the axe . . . and they were there!

It was 11.30 in the morning of 29 May 1953. It had taken them two and a half hours from the South Summit, which meant that they had only enough oxygen for two more hours. Hillary took off his set, got out his camera and began to take a panorama of the view—a priceless record from this observatory of mankind. After about ten minutes of this he realized that his fingers were beginning to freeze in spite of his warm gloves, so he quickly replaced his oxygen set and took a few whiffs of the life-giving gas. Meanwhile Tenzing had buried some chocolate, biscuits, and sweets as an offering from Buddhists to Chomolungma, 'Goddess Mother of the World'.

After a quick look round on the world below, which from the summit of Everest stood out like a relief map, they began the descent.

After Major J. O. M. Roberts had concluded his transport of oxygen equipment for the expedition, he had still five weeks in hand for interesting exploratory work to the south of the Everest group: Lumding Valley with Nambur (6955 m.) to the west of Namche Bazar, then the source of

the Inukhu and Hongu to the east of Namche, where he made the first ascent of Mera Peak (7437 m.).

Eight days after the ascent of Everest, on 6 June 1953, a four-engined Liberator of the Indian Air Force flew over the mountain. There were two photographers and two film-cameramen on board and they took some magnificent pictures—a revelation for climbers, topographers and geologists alike.

Pumori (7145 m.) to the west of Everest, was the object of two small expeditions in the summer and autumn of the same year—1953. Two Scotsmen, H. McInnes and J. Cunningham, attempted the mountain via the south ridge during the monsoon, and an Indian party led by N. Parekh tried again from the south in October. Neither attempt was successful. In spite of its relatively moderate height, Pumori should not be underestimated.

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4. EXPLORATION OF THE BARUN VALLEY

1954 There was much activity in the Everest group. Makalu (8470 m., 27,790 ft.) the fifth highest mountain in the world, and the ranges bordering the Barun Valley, were the objects of three large expeditions, American, New Zealand and French. The Sierra Club had obtained permission for an attack on Makalu in good time. This Californian Himalayan Expedition, under the leadership of Dr. William Siri, included W. Dunmire, R. Houston, F. Lippmann, W. Long, Br. Meyer, A. Steck, and W. Unsoeld. These climbers were joined by two scientists, Prof. N. Pace, physiologist and Dr. L. Swann, biologist.

The gorges of the lower Barun Valley are very difficult and frequently impassible. The best method of approach is from Sedua the last village, through the Kasua Khola and over the Barun La (about 4150 m.); from there one descends into the more open part of the Barun Khola. Five to six days must be reckoned from Sedua to the Base Camp (4700 m.) at the foot of the south face of Makalu. The Americans made a vigorous assault on the south-east ridge of Makalu and had reached a height of 7100 m. when the monsoon broke and forced them to retreat.

The leader of the Barun Expedition organized by the New Zealand Alpine Club was Sir Edmund Hillary. The other New Zealand members of the party were Bill Beaven, Jim McFarlane, Norman Hardie, Geoff

Harrow, George Lowe, Colin Todd, and Brian Wilkins. There were also two British members, Dr. Charles Evans, the well-known Himalayan expert, and Dr. Michael Ball, who came along as the expedition doctor. Three of the ten climbers, the two topographers Hardie and McFarlane and Dr. Evans, acted as cartographers, for which purpose the Royal Geographical Society kindly loaned three photo-theodolites.

In order to carry out the exploration of the terrain lying between Barun and Hongu Khola, the expedition was split up into three groups. An unfortunate accident occurred on the upper Barun Glacier, in which MacFarlane was precipitated down a crevasse. He sustained serious injuries and Hillary was also slightly hurt. Although the expedition leader had a long rest and had apparently recovered, he was taken ill while attempting the ascent of Makalu Col (7410 m.) at a height of 6700 m. and had to be carried back to camp with a high temperature under great difficulties. The rest of the party were able to climb the following peaks: Pethangtse (6724 m.), Chago (6885 m.), Baruntse (7220 m.), Cho Polu (6734 m.), Nau Lekh (6530 m.), and a number of other smaller peaks and passes. At the moment of writing, spring 1960, no map of the area covered by the expedition has been produced, apart from a few small sketches.

In the autumn of 1954, a very energetic French expedition went to the Makalu area. It consisted of six first-rate climbers: Jean Franco, leader, Jean Bouvier, Jean Couzy, Pierre Leroux, Guido Magnone, and Lionel Terray. Dr. Jean Rivolier was the expedition doctor, Abbé Pierre Bordet, the geologist of the party and the Sirdar was Gyaltsen Norbu in charge of ten Sherpas. The young Nepalese liaison officer, Dilli Bahadur Verma, unfortunately went down with acute pneumonia and died in spite of treatment with antibiotics and oxygen.

For acclimatization purposes, six 6000-m. peaks were ascended, some of them twice. After this the high camps were established, starting from the north-west basin (Glacier du Fer à Cheval). Camp 5 was placed on Makalu Col (7410 m.) which was reached for the first time. The first 7000-m. peaks were also climbed, Kangchungtse (7660 m.) and Chomo-Lönzo (7815 m.) which projects into the Kama Valley. Couzy and Terray got to 7800 m. on Makalu on 30 October, but violent storms prevented the establishment of Camp 6. Had this been possible it is more than likely that this reconnaissance expedition would have made the ascent of the fifth highest mountain in the world.

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In the spring of 1954 a British expedition financed by the *Daily Mail* and led by Ralph Izzard, set off to find the Yeti, the abominable snowman. The sole, not very satisfactory, results were a few photographs of footprints, a fleeting glimpse at night, the remarkable Yeti scalps of Khumjung and Pangboche and a multitude of local rumours. The full account of the Yeti saga is, however, extremely interesting.

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5. THE CONQUEST OF CHO OYU

The most important mountaineering event of 1954 took place in the autumn. Although Cho Oyu (8153 m.) was a relatively easy 8000-m. peak, the success of the small Austrian expedition, organized and led by Dr. Herbert Tichy was a fine achievement. Sepp Jöchler and Dr. Helmut Heuberger also participated and Pasang Dawa Lama contributed to its success. The icefall which turned back the Shipton expedition of 1952, this time offered no difficulty; in fact Pasang, who was in front, found a way through in an hour and the steep 60-m. pitch was soon rendered innocuous by means of fixed ropes. Camp 4 was set up above the fall on 5 October at about 7000 m.; the way to the summit was wide open, and a successful outcome seemed certain. However, a terrible storm broke during the night in spite of a cloudless sky, completely devastating the camp. While trying to save a tent, Tichy got his hands frostbitten and the party was forced to descend to Camp 1 (5800 m.), where they were warm and sheltered.

Pasang then went down to Namche Bazar in order to arrange for the rest of the equipment and more food to be brought up while Tichy tended his hands and Jöchler and Heuberger undertook a training tour on a small 6000-m. peak, the 'Tiroler Köpfl' (about 6300 m.) between Camp 1 and the Nangpa La. On 11 October Madame Claude Kogan and Bertholet of the French-Swiss Gaurisankar Expedition suddenly turned up. They had abandoned that mountain and hoped to find an easier and much better substitute in Cho Oyu.

A somewhat ticklish international incident thus developed. The Austrians naturally maintained that the Tichy Expedition had official per-

mission from the Nepalese government for an attempt on Cho Oyu, whereas the expedition led by Raymond Lambert of Geneva had permission for climbs in the Gaurisankar-Menlungtse group. An encroachment on the preserves of another expedition had never occurred in the Himalayas and there could be no question of merging the two expeditions, for Tichy wished to show that a small expedition was capable of accomplishing great things. Eventually, after much argument, an understanding was reached, whereby Lambert and Madame Kogan agreed to allow the Austrians to make their attempt, but without any delay. Thus, Tichy had to get going at once, although Pasang had not yet returned. Jöchler and Heuberger were now in good form, but Tichy still could not use his hands and had to wear three pairs of gloves over bandages. The situation was by no means a happy one.

Camp 3 at 6600 m. was dug out of the snow and there they spent three nights of storm. As provisions and fuel were running out, they could brook no further delay—their rivals were waiting in the wings. On 18 October they got ready without much hope, to go up to Camp 4 where they had come unstuck before. At that moment a Sherpa observed three men climbing up the snow ridge. Could it be the Swiss, tired of waiting? But no, it was Pasang with two Sherpas bringing up fresh food supplies and fuel. He had heard of the rival party and had rushed up the mountain at great speed with practically no rest and carrying a heavy rucksack. Nevertheless he did not appear to be fatigued and was ready to go on up to Camp 4 through the icefall. 'If the others reach the top before we do, I'll cut my throat!' he declared.

Next day, 19 October, three men, Pasang Dawa Lama, Herbert Tichy and Sepp Jöchler stood on the summit (8153 m.) at three o'clock in the afternoon. They were supremely happy and as Tichy said, 'It was well worth the cost of a few frozen fingers!'

As they did not wish to return empty-handed, Lambert and Madame Kogan attempted the second ascent of Cho Oyu, but an outbreak of bad weather combined with a bitter wind forced them to turn back at about 7600 m. Although the height they reached was not accurately determined, it can be assumed that Madame Kogan had at all events set up a new height record for the 'weaker sex'. (In 1934, Frau Hettie Dyhrenfurth with G. O. Dyhrenfurth, H. Ertl, and A. Höcht reached the western summit of Sia-Kangri (7315 m.) in the Karakorum).

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6. THE ASCENT OF MAKALU AND THE EVEREST MAP

1955 The main French expedition in the spring of 1955 was again under the leadership of Jean Franco, for many years head of the École Nationale d'Alpinisme at Chamonix. The other participants were: Jean Bouvier, Serge Coupé, Jean Couzy, Pierre Leroux, Guido Magnone, Lionel Terray, and André Vialatte. Also present were the doctor, André Lapras and the geologists Pierre Bordet and Michel Latreille. The Sirdar was once again Gyaltsen Norbu, in charge of twenty-three Sherpas. There were also 315 porters, led by Kindjock Tsering.

The ascent from the Barun Valley to Makalu Col (7140 m.) was fairly difficult, due to the open state of the glacier, and the route had to be made safe with fixed ropes. Camp 5 was set up on 9 May. There then followed a long, almost horizontal traverse of the north face, easy enough but exposed to falling ice. They forced a way through the séracs at 7650 m. and reached the upper glacier terrace. Here Camp 6 was installed, at an ideal spot on a level platform, sheltered and affording a magnificent view of Lhotse, Everest, and Tibet. At about 8000 m. the route led off to the left and they attained the ridge by means of a wide couloir lying at an angle of 45-50 degrees. This *arête*, easy at first, gradually became narrow and corniced and finally led them to the summit.

For the first time in the history of Himalayan exploration, all the members of an expedition reached the summit: Couzy and Terray on 15 May, Franco, Magnone and Gyaltsen Norbu on the 16th, and Bouvier, Coupé, Leroy and Vialatte on the 17th. The weather and snow conditions could not have been better; everybody was on top by midday and it was so warm and windless that all parties remained for hours on the summit. They reached Camp 3 (6400 m.) that afternoon. It was almost an anticlimax that the mighty Makalu, long held to be one of the most formidable of the 8000-m. peaks should have yielded so easily. Allowing for the organization and leadership of the undertaking, the superb effort of the French crack climbers and the excellence of their equipment, two factors dominated the success: the first-class French oxygen sets and a degree of luck which had never before been accorded to any Himalayan expedition. The same party were forced to retreat in the autumn of 1954, despite most strenuous efforts, whereas in May 1955 they had a resounding victory without the expenditure of excessive energy. It would appear that the pre-monsoon period is the best time for climbing.

According to the reports of the French party, they found Makalu—given splendid weather and first-class oxygen sets—hardly more exacting than an ordinary ascent of Mont Blanc. The French found Makalu a



PLATE 21. The Monastery of Thyangboche, 3900 m., the religious centre of the Sherpas of Khumbu



'*montagne heureuse*', in striking contrast to the grim struggle on Anna-purna 1 (8078 m.) in 1950.

Some excellent scientific work was produced by the doctor, J. Rivolier and the geologists Bordet and Latreille.

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Close to the scene of the French Makalu expedition, the International Himalayan Expedition 1955 (I.H.E. 1955), was operating in Khumbu. It comprised Swiss, Austrian, and American nationals. The leader was the American-Swiss Norman G. Dyhrenfurth, Erwin Schneider was the cartographer and the leader of the climbing party was Ernst Senn from Innsbruck. In the autumn the party was joined by two Swiss—Arthur Spöhel and Dr. Bruno Spirig—and three Americans—George I. Bell, Fred Beckey and Richard McGowan.

A short summary of the results of the expedition was as follows:

Mountaineering: Thirty-one peaks between 5500 and 6900 m., mostly first ascents. First ascent of the steep Nepalese face of Lho La (6006 m.), lying between the west shoulder of Everest and Lingtren, which had previously only been climbed from the Rongbuk side. First attempt on Lhotse (8501 m.), which was climbed up to a height of 8100 m. from the Western Cwm by Senn.

Photography: More than 10,000 pictures, some in colour, from 24 × 36 mm. (Leica) up to 13 × 18 cm. (Topo plates). Not only were the mountains abundantly photographed but a large number of pictures were made of the population of Khumbu, their habits and customs, and life in the Lama monasteries.

Films: 9000 m. of 16 mm. commercial Kodachrome were exposed for culture films and also recordings on magnetized tape.

Cartography: First stereo-photogrammetric map of the Nepal side of Everest to a scale of 1:10,000. The beautiful Schneider-Ebster map was produced to a scale 1:25,000.

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PLATE 22. Sherpas from Khumjung drinking tea out of porcelain cups with silver lids and holders

Also this year there was the small Mount Chamlang Survey Expedition, led by Norman D. Hardie, which endeavoured to make a topographical survey of the area west and south of Chamlang (7317 m.) by means of journeys through Inukhu, Hongu, and Sangkhua Khola. During the course of the summer, he lived in Khumjung like a Sherpa, studying the ethnology of Khumbu on the spot. He was joined in the autumn by his wife and the New Zealander, A. J. Macdonald.

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7. TWO 8000-M. PEAKS AT ONE BLOW. EVEREST AND LHOTSE

1956 A large Swiss expedition to Everest was very carefully organized and prepared by the Swiss Foundation for Alpine Research of Zürich for 1956. Albert Eggler of Berne was the leader of the party consisting of the following: Wolfgang Diehl (Berne), Dr. Hans Grimm (Wädenswil), Dr. Hansrudolf von Gunten (Berne), Dr. Eduard Leuthold (Zürich), Fritz Luchsinger (Thun), Jürg Marmet, oxygen specialist (Zürich), Dr. Fritz Müller, geographer (Zürich), Ernst Reiss (Interlaken), and Ernst Schmied (Berne). There were eleven in all and the climbing party mostly came from Berne or the Bernese Oberland.

Base Camp was established at about 5370 m. on 7 April, not on the moraine island site of the former British Everest expeditions, but a little further to the north, closer to Lingtren. Advanced Base Camp in the Western Cwm (6400 m.) was numbered 3 this time. On 1 May Camp 4 was set up on the lower terrace of the Lhotse Glacier and a site for Camp 5 (7400 m.) was marked on a terrace below the 'yellow band'. At this spot a traverse was made, secured by a rope balustrade, to the lower station of a rope windlass on the Lhotse Face. The upper station near Camp 6a was situated to the south-west, below the shoulder of the Geneva Spur.

The windlass was to have been working by 10 May, but it began to snow hard and Camps 4 and 5 had to be evacuated. It cleared up on 14 May and the track was remade up to Camp 6a, and beyond as far as the shoulder of Geneva Spur (8020 m.). Camp 6a was occupied on 17 May by Reiss and Luchsinger, Camp 5 by Reiss and Gunten, Camp 4 by Eggler and Schmied, while the rest of the party remained below in Base Camp.

After a very cold night (-25° C. at Camp 5), Ernst Reiss and Fritz Luchsinger started off for an attempt on Lhotse (8501 m.) on 18 May and following a fault traversed across to the Lhotse couloir. This great gully,

which constitutes practically the only possible route, is, for 500 m. of its length, considerably steeper than the Marinelli Couloir on the east face of Monte Rosa and is only practicable when the snow is hard and in good condition. By about midday they had reached the crux of the climb, a rock barrier which interrupts the course of the couloir, and here they drove in two pitons. They reached the top six hours after leaving camp. There was no room to sit down on this savage summit and their rucksacks had to be suspended from two rammed-in axes. Great care had to be exercised in taking photographs. The view of the serrated ridge of Lhotse and of Everest beyond was of extraordinary beauty. The wind was getting up, their hands and feet lost all feeling and their oxygen had given out. It was time to go down.

The exposure of the summit slope and the steepness of the couloir were impressive. They descended with extreme caution, moving only one at a time with careful attention to belays. At the end of an hour they arrived above the narrowest part of the gully, where they suspended 40 m. of line from a piton, using it as a fixed rope. Things gradually became easier, the couloir was behind them, and they soon reached Camp 6a by means of the great traverse. They got to the single tent at 18.15 hours, tired out but in good spirits. They found the tent buried under powder snow, which they had to dig away before they could make an entry and crawl into their sleeping-bags.

Meanwhile the attack on Everest was getting under way. There was much activity with the windlass. Operating this device at a height of 7900 m. was a laborious and tiring job. The hauling 'rope' was a thin steel cable 700 m. long to which were attached two light metal sledges each carrying two loads. Camp 6a was established on an unpleasantly steep slope and was only made possible by means of the windlass. A further Camp (6b) was erected by Eggler on 21 May above the shoulder of the Geneva Spur (8020 m.) on the South Col. It was situated at 7986 m. about 100 m. westward of the British camp site of 1953. They found a lot of equipment abandoned by the British, such as oxygen bottles, a primus stove, and some tinned food.

Schmied and Marmet with four Sherpas set up Camp 7 (8400 m.) on 22 May, consisting of a two-man tent, about 100 m. below the highest British camp of 1953. Next day they made the second ascent of Everest, using four litres of oxygen per minute. The weather was magnificent and they were able to spend about an hour on the summit. At Camp 7 they met Dölf Reist and Hansrudolf von Gunten who, with the assistance of the faithful Da Norbu, were in the act of digging out the buried tent. Schmied and Marmet attached the Sherpa to their rope and all three descended to the South Col.

The second rope was also successful. The night was again cold, but the next day, 24 May, was the finest for weeks. They set out at 06.45 hours, reached the South Summit by ten o'clock and were on the top by 11 a.m. The air was so still that their little flags did not stir. Reist and von Gunten remained for two hours on top, during which time they were able to behave as though they were on an Alpine peak on a fine summer's day. They took photographs, changed films, ate with a good appetite, and were able to do without oxygen. They left the summit at 13.00 hours and although they picked up a lot of equipment at Camp 7 and were carrying a load of rock samples, they reached the South Col at 15.00 hours.

As Eggler, Schmied and Marmet, with two Sherpas, were crossing the shoulder of the Geneva Spur, they met a strong party of ten on the way up. They were Fritz Luchsinger and Ernst Reiss with the doctor, Eduard Leuthold, and the glaciologist, Fritz Müller, as well as six Sherpas. They were on their way up to the South Col in case their help might be needed on the mountain. It was obvious that their services would not now be necessary and for a moment they toyed with the idea of getting a third rope on the summit. But Eggler, as the responsible leader of the expedition, felt that they must not push their luck too far, in any case they had already achieved more than enough. The monsoon was approaching and the latest met. reports were full of foreboding.

The high camps were evacuated and everybody prepared for the homeward journey except Dr. Fritz Müller, who remained in Khumbu until December in order to continue and complete his glaciological and meteorological investigations. These also reached a successful conclusion.

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8. 1957 TO 1960

1957 This was an off year for the Everest group. In the spring, Tom Slick of Texas and Peter Byrne of Ireland undertook a three-weeks Arun Expedition and somewhere between Choyang and Iswa Khola came across tracks which they took for footprints of a Yeti. They photographed

them and as these footprints were on earth, it was possible for the first time to take a proper cast.

1958 Tom Slick financed a larger Yeti Expedition in the area of the Arun and its tributaries, under the leadership of the zoologist Gerald Russell. Three hounds which they took with them were found unsuitable for use in the primeval forest and proved to be a great nuisance when it came to climbing through deep gorges and crossing difficult rivers. The expedition formed the conclusion that there were two types of Yeti, one which lives in the rain forests between 2400 m. and 3600 m. and is about 4 ft. 8 in. high and another which dwells between the highest human habitations and the glacier regions, attaining a height of between 6 ft. and 8 ft. The expedition did not, unfortunately, succeed in producing definite photographic evidence.

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1958 This year there was an Indian expedition to Cho Oyu, led by Keki F. Bunshah of Bombay. The expedition had a bad start, for almost at once, on 28 April, Major Narendra Dhar Jayal, head of the Himalayan Mountaineering Institute of Darjeeling, died of pneumonia and was buried at the foot of Cho Oyu.

They set out again on 9 May and on the 15th the summit was reached, but only by two very experienced Sherpas—Pasang Dawa Lama, and Sonam Gyaltsen. Pasang, who was once more the leader on this second ascent of Cho Oyu, was fêted in Kathmandu and received by Nehru in New Delhi. It was the first time that a mountain of this height had been climbed without Europeans. The Himalayan mountain spirit is evidently on the march in the sub-continent of India.

1959 This was a disastrous year in the annals of the Himalayas and the Karakoram. There were two serious accidents in the Everest group. In the spring a British expedition led by J. H. Emlyn Jones made a fresh attempt on the beautiful Ama Dablam (6856 m.), from the Imja Basin via the north ridge. On the morning of 21 May, a rope consisting of M. J. Harris and G. J. Fraser was seen on the ridge at about 6560 m. Mist came down and nothing more was seen or heard of the pair. It is possible that they had reached the summit and fell during the descent.

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In the autumn, Cho Oyu, one of the easier of the 8000-m. peaks, was once more the goal, this time by a woman's international expedition. It consisted of twelve women: four French—Madame Claude Kogan the leader, Madame Jeanne Franco, Madame C. Le Bret, doctor, Mlle Rambaud, photographer; three British: Miss M. Darvall, Mrs. D. Gravina, Mrs. E. Healey; a Belgian—Mlle Claudine van der Stratten; a Swiss—Mlle Loulou Boulaz and three Nepalese girls, Duma, P. Norkay and N. H. Norkay.

Little time was expended on the well-known icefall and on 1 October Kogan and Van der Stratten left Camp 4 with the Sherpa Ang Norbu for the summit. The weather turned bad, heavy snow falling with a low temperature. In spite of this, Sirdar Wangdi went up the mountain from Camp 2 (6400 m.) with the Sherpa Chhowang in order to render assistance to the summit party. Above Camp 3 (6800 m.) they were overwhelmed by an avalanche, Chhowang was buried deep but Wangdi was able to free himself after a two hours' struggle. He got down to Base Camp with frostbitten hands.

When the weather cleared on 5 October, it was seen through binoculars that a great avalanche had swept over the site of Camp 4. This was confirmed on the spot a couple of days later by J. Franco and D. Gravina. Claude Kogan, Claudine van der Stratten and Ang Norbu were most probably surprised in their tent on 2 October and buried by the avalanche. Chhowang perished in his gallant attempt at relief. It is now quite evident that the high mountains should not be attempted under post-monsoon conditions.

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1960 Everest was attempted from the north and the south. A Soviet expedition is said to have operated in 1952, led by Dr. Pawel Datschnolian. The leading rope is said to have reached a height of 8220 m. and then disappeared. The report of this accident, emanating from Tibet, was later denied by the Soviet Union. As this story cannot be checked, it should be treated with reserve. A report from Peking stated that three Chinese—Wang Fu-chu, Chu Jin-hua and Konbu (a Tibetan) reached the summit of Everest from the north on 25 May. Photographic evidence was not forthcoming, as they did not reach the top until one o'clock in the morning and owing to darkness it was not possible to take photographs. At this time there was an Indian expedition led by Brigadier Gyan Singh on the south-east ridge of Everest, which was forced to retreat owing to heavy snowfalls. This hardly supports the story of the Chinese party.

The Indians were only a few hundred metres from where the Chinese were supposed to be. Until further notice any reports of such successes from Red China should be treated with the utmost reserve. The summit of Mount Everest is now obviously in the forefront of the 'cold war'.

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3

THE SHERPAS OF THE KHUMBU REGION

Christoph von Fürer-Haimendorf

The field-work on which this account of the Sherpas is based was carried out in the years 1953 and 1957 under the auspices of The School of Oriental and African Studies, University of London, and the Wenner-Gren Foundation for Anthropological Research.

I. ORIGINS AND DISTRIBUTION

The regions along the borders of Nepal and Tibet are inhabited by peoples of Mongoloid race akin to Tibetans in language and culture and generally known by the term Bhotia. In the high country close to the Himalayan main range there are compact areas of Bhotia population, but farther south Bhotia settlements, situated on the crests of ridges, dovetail with the villages of other ethnic groups, which occupy the lower slopes and valleys. The anthropological exploration of Nepal is not yet sufficiently advanced to permit a systematic classification of the Bhotia populations, but from accounts of travellers, and of scholars not specifically engaged in ethnographic observation, it appears that there are considerable regional variations, corresponding perhaps to similar variations in the populations of the adjoining regions of Tibet. One group of Bhotias, however, stands out by virtue of its long association with Nepal no less than by the fame its members have attained as mountaineers and high altitude porters. The Sherpas of eastern Nepal have a sense of a distinct ethnic identity which clearly sets them apart from other high altitude dwellers of Tibetan stock.

The name Sherpa is said to be derived from the Tibetan *shar-pa*, which means 'easterner', but it is not clear in what manner this term came to be associated with the particular group now known as Sherpa. From the Tibetan point of view Sherpas are southerners rather than easterners, and even within a purely Nepalese setting there is no real justification for the term, as Bhotias not described as Sherpas dwell to the east as well as to the west of the Sherpa country. But whether justified or not, the term has

come to stay and is used by the Sherpas to distinguish themselves from other Bhotia groups.

The principal concentration of the Sherpas is in the three regions of Khumbu, Pharak and Solu. Khumbu, which stretches from the Tibetan border to the confluence of the Dudh Kosi and the Bhote Kosi is a region where the villages lie at an average altitude of 12,000 to 13,000 feet, and summer settlements and grazing grounds extend above the 16,000-foot line. Pharak is the narrow strip of country lying to both sides of the Dudh Kosi between its confluence with the Bhote Kosi and the gorge above Jubing. In this area the villages lie on the banks of the river, as well as on broad, gently-sloping ledges high above the level of the Dudh Kosi. Solu, which is the Nepali name for an area known in Sherpa as Shar-rang, lies south-west of Pharak, and includes the broad valley of the Solu River and several side valleys. Here there are no deep gorges as there are in Khumbu and Pharak, and the gentle slopes offer better prospects for large-scale cultivation. The collective term Solu-Khumbu or Shar-Khumbu is sometimes used for the entire area consisting of the three regions of Khumbu Pharak and Solu. But even though the Sherpas of these regions constitute in some respects a single society, the use of this term is nevertheless inadvisable for our purpose. Conditions in Khumbu differ radically from those in Solu, and little that will be said of the Sherpas of Khumbu is appropriate to those living in Solu.

West of Solu there are some Sherpa villages in the upper part of the Likhu Khola Valley as well as on the hills flanking the Khimti Khola. A small but compact group of Sherpa settlements is situated in the Rolwaling region, which a perilous track, leading across a high pass known as Teshi Lapcha, connects with the western part of Khumbu.

Another area of Sherpa settlement extends to both sides of the upper course of the Sun Kosi and in a region known as Yelmu (or Helmu), which lies three days' walk north-east of Kathmandu. The inhabitants of Yelmu describe themselves as Sherpas, and though their dialect and many features of their material culture differ from those of the Sherpas of eastern Nepal, these differences do not stand in the way of occasional marriage alliances with Sherpas of Solu. Separated from Yelmu by a mountain range the crossing of which presents no difficulties to hardy hillmen, lie the valleys of the Langtang Himal, but it would seem that the Bhotia population inhabiting these valleys does not claim the name Sherpa, and there is little or no intermarriage between the inhabitants of Yelmu and those of Langtang.

Farther west I have encountered only isolated groups of Sherpas. The largest of these is a group of some 300 families distributed over several villages in the hills to the north of Pokhara. They claim to have migrated

there from an earlier home in Yelmu some three generations ago, and the dialect they speak indeed resembles that of the Yelmu Sherpas.

To the east of Khumbu and Pharak the distribution of Sherpas extends across the Inukhu Khola into the hills flanking the Hongu Khola. This compact Sherpa area, broken only by Rai villages occupying the lower parts of valleys, reaches as far as the range of mountains which forms the watershed between the Dudh Kosi and the Arun River. Beyond this range there are several villages of Sherpas whose forefathers emigrated from Solu and Pharak only three generations ago. More or less isolated villages of Sherpas belonging to the same clans as those represented in Solu are found on both sides of the Arun, but as one follows the Arun upstream, one comes into a region inhabited by Bhotias of different origin. They claim to have come directly from Tibet, and not like their Sherpa neighbours by way of Khumbu and Solu. There are also colonies of Solu Sherpas far to the east of the Arun River, and it seems that the eastward drift of Sherpas did not halt on the borders of Nepal. In the Darjeeling District of Bengal the strength of the Sherpa community had in 1947 reached 6,929, a figure which no doubt included many emigrants from Khumbu, who lived in the Sherpa quarter of Darjeeling town.

2. THE SETTLEMENT PATTERN

Although the population of Khumbu represents only a fraction of the total number of Sherpas, it is a group of vital importance for an understanding of the characteristic features of the Sherpa way of life. For in the high valleys of Khumbu, remote from the influence of the peoples inhabiting the middle ranges of Nepal, Sherpa society and culture has developed on its own lines: adaptation to an inclement habitat has led to intensive specialization in such economic activities as yak-breeding and trade with Tibet; the great distances that separate Khumbu from the centres of state administration have allowed the growth of a particular type of local government and authority system; and close contact with Buddhist monasteries beyond the Himalayan main range has favoured the development of religious institutions, so that today Khumbu can boast of monasteries that enjoy a reputation even beyond the frontiers of Nepal.

The pattern of Sherpa settlement in the Khumbu region has been shaped by a climate and an environment which precludes the possibility of combining mixed farming with a sedentary way of life. No single locality above the confluence of the Dudh Kosi and the Bhote Kosi possesses resources which alone would enable its inhabitants to maintain themselves and their livestock throughout the year. In order to secure a constant

supply of food for his animals the yak-owner must continually move with his herds from pasture to pasture; and the Sherpa owning no cattle must supplement his income from the tillage of the soil by extensive trading excursions. Neither can afford to spend the greater part of the year in one place. The trader has usually only one permanent house, and every year travels for many months in regions beyond Khumbu. But the cattle-owner requires habitations in a number of subsidiary settlements.

It is the herdsmen's habitations at different levels of altitude which lend the settlement pattern of Khumbu its distinctive character. This pattern is composed of settlements of several types. There are, above all, the main villages, where people have their principal houses and most of their household goods, where there are village temples and where communal rites are performed. Besides the main villages there are subsidiary settlements, situated at different levels of altitude, where the houses are smaller and less well furnished and where people stay only at specific times of the year. Those lying in sheltered valleys at altitudes lower than the average altitude of the main villages are inhabited mainly during the coldest months of the winter, whereas settlements in the high pasture lands above the tree-line are populated mainly, though not exclusively, during the summer months.

While the map of the Khumbu region is dotted with numerous subsidiary settlements the number of main villages is strictly limited. In the triangle enclosed by the Dudh Kosi and the Bhote Kosi there are Namche Bazar, Khumjung and Kunde; in the upper Dudh Kosi Valley there is Phortse, and in the valley of the Inja Khola there is the ancient village of Pangpoche, and the comparatively recently founded village of Milingbo. In this valley lie also the two monastic institutions of Tengpoche and Devuche, but though permanently inhabited, these do not fall within the category of main villages. In the valley of the Bhote Kosi the position is more complex. Here we find the main villages of Thamo, Thami and Thamote, which are collectively known as Thamichok, as well as a number of smaller permanently inhabited villages which, though spatially separated from each other, combine in ritual matters and thus assume collectively some of the characteristics of a main village.

The villages of Khumjung (93 houses), Kunde (45 houses), Phortse (63 houses), Pangpoche (58 houses) and Thamichok (192 houses distributed over three settlements) all lie in localities which allow for fairly extensive cultivation. In the rugged country of Khumbu, where mountains of over 25,000 feet sweep up from narrow valleys, level land is exceedingly scarce, but wherever a broader valley or a sizeable ledge lies between mountain and river-gorge and offers scope for cultivation main villages are to be found.

The availability of arable land is not the only factor determining a site's suitability as a main village. There must be a perennial source of water and an adequate supply of firewood within reasonable reach. Settlements such as Dingpoche in the upper Imja Khola Valley, which lie at too great a distance from the nearest wood-reserves, are not suitable as sites for main villages, even though there may be sufficient arable land and ample water.

Among the main villages Namche Bazar, known in Sherpa as Nauje, occupies a special place. It is principally a settlement of traders, and the cultivable area is so small that only a few of its seventy-three households can support themselves by the pursuit of agriculture.

Despite great variations in local topography, the layout of the main villages follows a preferred pattern. The houses singly or in small groups stand with their kitchen gardens in between fields enclosed by stone walls. Nowhere do we find a configuration even vaguely reminiscent of a village street. Though two or three houses may stand in line they never face each other, and indeed it is usual for all houses of a village, or at least each part of a village, to face in the same direction. Thus all the fifty-five houses of Phortse, except one, face the Dudh Kosi gorge and a modification of this pattern occurs only in Namche Bazar where the houses stand in a semicircle, built against the slopes of a natural amphitheatre. Here the limitations of the site do not permit the usual dispersed pattern; fields and gardens are small or non-existent, and many of the houses stand closely crowded together.

The architectural style of the Sherpas of Khumbu is one of great uniformity. All dwelling houses are built to one plan with stone walls, plastered and whitewashed on the outside. Roofs, supported on a framework of stout wooden beams, are tiled with broad wooden slats and these are weighted down with large natural stones. Sherpa carpenters do not use nails, but they are nevertheless capable of constructing durable roofs, wooden plank floors and panelling for the interior of rooms, and some of them are expert at carving the wooden doors, windows and lintels which are to be found in every dwelling.

Most Sherpa houses are double-storied. At ground level there is space to store firewood and provide shelter for calves and oxen in cold weather. A flight of wooden stairs leads up to the first floor which is almost completely occupied by a living-room. The arrangement of this room, which may be anything from 25 to 40 feet long and 10 to 12 feet broad is everywhere the same: it contains an open hearth for cooking and heating, and under the windows runs a broad bench; in front of the bench is a long low table. The seat of the house-owner is next to the open fireplace and the place of honour is next to the host. The walls of the room are

generally panelled in wood and at least one is lined with wooden shelves which, in the houses of the wealthy, are filled with rows of shining copper and brass vessels. One corner of the room contains the wooden bedstead of the house-owners, but other members of the family as well as guests sleep on the floor, spreading their bedding each night and rolling it up each morning.

In many of the larger houses there is also a private place of worship. This is usually a square room situated at the end of the living-room—the entrance being through a wooden door in the end wall—and between them a space may be boarded in for an extra bedroom or store. The place of worship contains an altar with carved wooden or plaster figures representing the saints and divinities of the Buddhist pantheon, and the panelled walls are decorated with religious frescoes or free-hanging painted scrolls. On one side there are usually some shelves on which are arranged a small collection of hand-printed sacred books.

The domestic and social life of a Sherpa family takes place in the living-room. Here food is cooked and consumed, guests are entertained, business is transacted, hired craftsmen such as tailors and shoemakers work, and the women and young girls gather for spinning parties. On festive occasions the living-room becomes a dance hall, and the floor-boards vibrate under the rhythmic steps of dozens of dancers.

In every village there are also several single-storied houses, which lack a proper store-room on the ground floor. But it is the ambition of every Sherpa to own a double-storied house, and only impoverished families or those who have recently immigrated from Tibet are content to live for some time in such a poor and inconvenient dwelling.

Religious buildings are found in all main villages. Temples or structures housing prayer-wheels, either alone or in groups, occupy a central position; they are built according to the same principles of construction as the dwelling houses, but the decoration is more elaborate, the walls being painted varying shades of terracotta and the roofs being surmounted by gilded spires. They are the principal distinguishing mark of a main village, for no such structures appear in subsidiary settlements. Other religious edifices found in all main villages, as well as occasionally in subsidiary settlements and on passes far removed from human habitation, are stupa-like *chorten* and *mani*—isolated natural rocks or slabs of stone assembled in wall-like formations, each of which bears an inscription in Tibetan characters. Some of the main villages boast a free standing village gateway; this is a square edifice with frescoes in vivid colours on the inside.

Apart from these religious structures, there are no public buildings of any kind. Sherpas accommodate travellers and traders in their own houses,

and hence there is no need for the rest-houses which feature in the villages of many other parts of Nepal. Public gatherings of a secular nature are usually not held in buildings, but in the open, and in most villages there is a roughly circular, raised platform for this purpose. Religious gatherings, on the other hand, take place in the temple or in the temple courtyard.

A Sherpa village consists not only of homesteads and individually owned, walled-in gardens, fields and meadows, but also of pasture and forest-land held jointly by the community. All villages are entitled to utilize the village lands, but the exploitation of the produce growing on them is carefully controlled. At altitudes above 12,000 feet wood is a scarce commodity and trees growing within village boundaries may only be felled for specific purposes; firewood must be brought from more distant areas. Pastures in the vicinity of villages are liable to over-grazing, and whereas every villager has the right to graze his cattle and cut grass for storage as winter fodder on common land, the village assembly, meeting at least once a year, decides which areas must be kept clear of cattle during the ensuing months so as to allow for a period of recuperation.

The members of a village community have also the right to graze their cattle on pastures far removed from the main village-lands, but this right is not exclusive; members of several villages share the use of the same pastures and cultivate land in the same subsidiary settlements.

The subsidiary settlements fall into two distinct categories. Those known as *gunsa* are situated at altitudes below that of the main villages, either on sheltered ledges or on narrow strips of level land along the river banks. Protected from icy winds by mountains rising steeply from gorge-like valleys, they enjoy a milder climate than the main villages, and it is for this reason that many families move to *gunsa* settlements for the coldest part of the winter. *Gunsa* settlements provide additional opportunities for potato cultivation, the planting and harvesting being earlier than in the main villages, but also convenient grazing for cattle, especially at those times when the main village-lands are closed to all livestock.

Subsidiary settlements of another category are those known as *yorsa* or *phu*. Their role is altogether different. Situated in the vicinity of high pastures, many of them above the tree-line, they comprise dwelling houses and walled-in meadows; in all except the very highest there are also a few potato plots which are planted and harvested later than those in the main village. The grass growing on the walled-in meadows is cut and dried; and the hay stored for use as fodder in the autumn and spring when the surrounding terrain is covered in snow.

Yorsa lie at distances of up to two days' walk from the nearest main village, and most yak-owners possess houses in several such high altitude

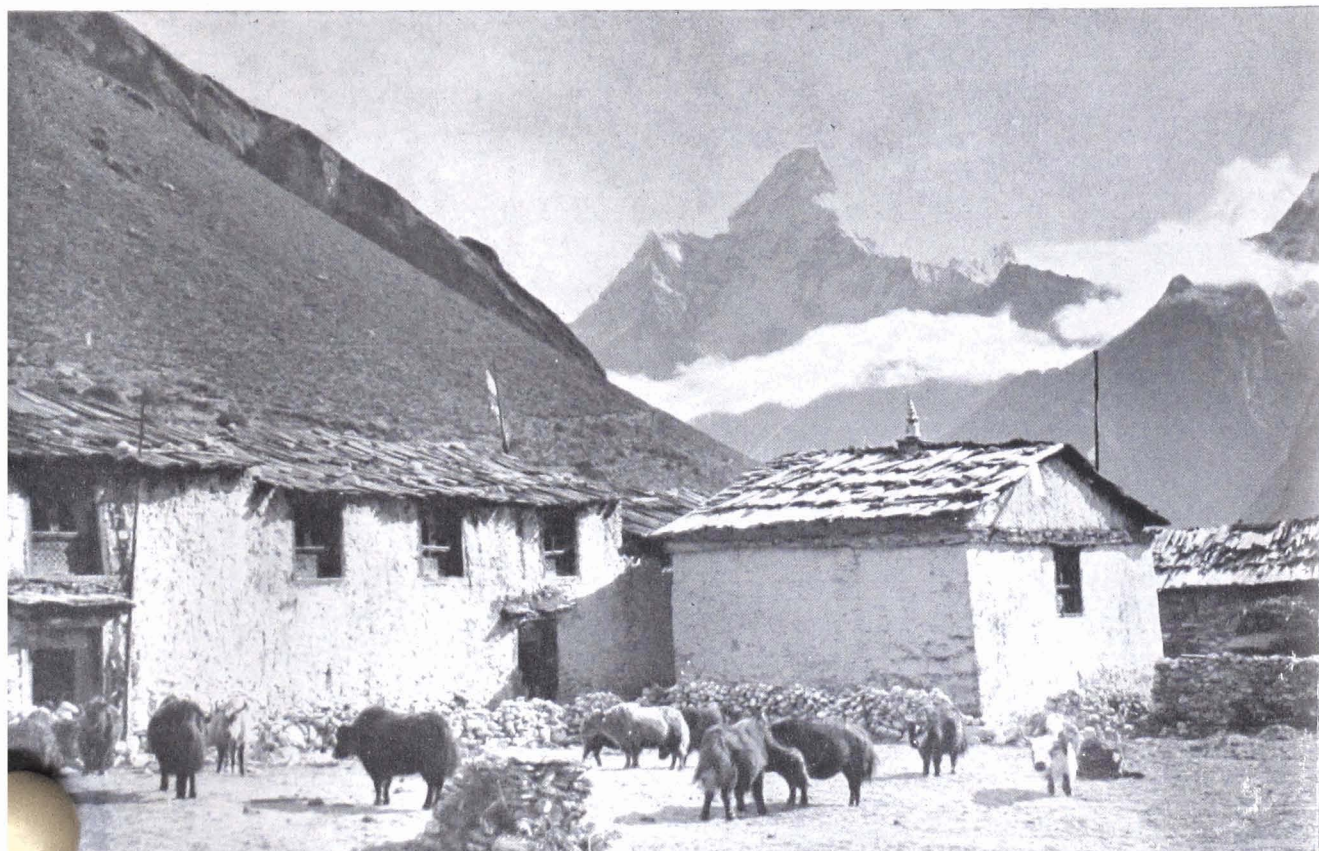
PLATE 23. The huge south face of Lhotse, 8501 m. As the foot of the face is at an altitude of 5400 m., the height of the face is 3101 m. A frontal bending over of the strata has produced the greatest overhang on earth, about 1000 m. The series of 'Yellow Bands' is clearly visible at the top of the face





PLATE 24. A Sherpa greets a Lama by touching his forehead

PLATE 25. A Sherpa house in Khumjung with its private place of worship. A yak herd in the foreground with Ama Dablam, 6856 m., towering up in the distance



settlements. The highest *yersa* in the Mount Everest region are Lobuche (16,175 ft.) close to the Khumbu Glacier and Chukhung (15,978 ft.) on the Imja Khola. Another such settlement at great altitude is Gokyo (about 15,600 ft.), which lies on the shores of the Gokyo glacial lake, close to the source of the Dudh Kosi.

The houses of *yersa* and *gunsa* settlements are built of stone and roofed either with wooden boards or stone slabs. Whereas in most *gunsa* settlements there are at least some double-storied houses, the dwellings at high altitudes, where all timber has to be brought from a great distance, are usually single-storied and contain only a minimum of furnishings.

Similar in purpose to the *yersa*, but different in form are encampments known as *resa*. These consist of roughly built stone walls, which when occupied are temporarily roofed with yak-hair blankets or bamboo mats. Serving the herdsmen as shelter on pastures where it is convenient to graze cattle for a few days, but where there is no site suitable for a more permanent settlement, they are found at very great altitudes, sometimes above the highest *yersa*, and again at fairly low levels, sometimes so close to the main village that they are within easy walking distance. While children can be entrusted with the task of herding during the daytime, adults need only spend the night in the *resa* and so be at hand to guard the cattle against attack by wolves or leopards.

Ownership of property in *gunsa* and *yersa* settlements is an indispensable concomitant of yak-breeding. Without such dispersed holdings it is not possible to maintain even a moderately-sized herd, and all yak-owners spend a large part of the year moving with their herds from one subsidiary settlement to another. Inhabitants of subsidiary settlements are not necessarily members of the same village community, and the houses, meadows and potato plots in a subsidiary settlement may belong to men from different main villages. The families that congregate periodically in a subsidiary settlement should therefore not be viewed as an extension of a main village community, but as a temporary local group, which for certain limited periods share a common habitat, utilize the produce of surrounding lands, and disperse after co-residence of a few weeks.

The original impetus for the founding of subsidiary settlements and the building of houses on high-lying pasture lands must undoubtedly have sprung from the needs of herdsmen who required shelter and fodder in the vicinity of good grazing grounds. Today, however, it is not only the owners of herds who own houses and land in subsidiary settlements. Families, whose main livelihood is gained in agricultural pursuits, find it equally advantageous to extend their agricultural activities over plots situated at varying altitudes, where crops are planted and harvested earlier and later than in the main villages.

Main villages and subsidiary settlements are the habitations of the Sherpa laity. Besides them there are monasteries and hermitages, where monks and nuns lead a life devoted to meditation and religious practices. The composition of these monastic institutions, whose principal structures surpass in size and artistic quality all Sherpa dwelling houses, will be discussed in some detail in connection with the role of the Buddhist priesthood in Sherpa society.

3. AGRICULTURE AND SEASONAL NOMADISM

During six months of the year the soil of Khumbu is frozen and all agricultural operations are at a standstill. While the Sherpas of Pharak and Solu cultivate winter wheat and barley, and sow in early summer buckwheat, maize and potatoes, the inhabitants of Khumbu must be content with the produce of one agricultural season. The choice of crops that can be cultivated at an altitude of 13,000–14,000 ft. is limited. In most of Khumbu only buckwheat, potatoes, white turnips and a spinach-like vegetable are grown, but in the high valley of Dingpoche where there are possibilities of irrigation, the Sherpas have succeeded in raising a type of bearded, short-stemmed barley.

The agricultural season commences at the end of March or, after a severe winter, early in April, when the members of those households which own fields in *gunsa* settlements, go there to dig up the ground and plant potatoes. As soon as the ground in the main villages is free of snow, work starts on the repairing of the stone walls, which enclose all fields. About two weeks before the potatoes are to be planted groups of women, working with long-handled hoes, dig up the potato fields. After the potatoes have been planted, turnip seed is dibbled into the newly turned soil between the potato rows. These operations, the digging up of the fields and the planting of the potatoes and turnips, is women's work and only when it is time to plough the land which will be sown with buckwheat do men take part in the work on the fields.

The traditional Sherpa method of ploughing requires no draught animals. The wooden plough, with its narrow iron-tipped share, is drawn by four men; a man guides the plough, and a woman, walking behind, broadcasts the seed. Nowadays some men have taken to plough with yak or yak cross-breeds, but this method is not very popular in Khumbu and in 1957 there were, in the two villages of Kunde and Khumjung, only four Sherpas who used draught animals. The reason why the Khumbu Sherpas have been slow to adopt this method of ploughing is mainly the difficulty of training, and the expense of keeping, animals specifically for an operation which takes the average farmer only one or two days a year.

The majority of the land of Khumbu is used for the growing of potatoes, for which the Sherpas consider ploughing an inadequate preparation; only a small part of the agricultural land is given over to the cultivation of buckwheat.

Potatoes grow exceptionally well in the sandy soil of Khumbu, and can be planted in the same fields year after year. Buckwheat, on the other hand, must be grown alternatively with potatoes and as long as this rotation is followed, it is not necessary to leave any part of the land fallow. Manuring with human excrement from the latrines and litter straw is only carried out on those fields on which cattle are never penned. The fields near the houses, where the herds graze during autumn and winter are adequately fertilized by animal droppings.

While the crops are growing the fields must be weeded once, and if possible twice; this work begins in June and is carried out by women.

During the summer months agricultural work in the main villages comes to a standstill, for at this time of the year most Khumbu Sherpas are living in subsidiary settlements. Family members are scattered over a wide area: the men remain with the herds on the high pastures until the middle of September but women are engaged in lifting potatoes from mid-August, first in low-lying *gunsa* settlements and then in the main villages.

The cutting of buckwheat starts as soon as the potatoes are out of the ground. Men and women cut the crop with sickles and beat out the grain on threshing floors situated in the fields. The harvesting of potatoes in *yorsa* settlements is done after the harvests in the main villages have been gathered; it is at this time that those Sherpas who own land in Dingpoche go there to reap the barley. This is not cut, but pulled out by the roots and spread out on the ground to dry.

The harvesting of hay takes place simultaneously with that of potatoes and grain crops. Grass is cut on high pastures in early August and grass-cutting on hill slopes and meadows at lower altitudes continues until the first weeks of October. The grass is dried in the sun and stored as winter fodder.

In these weeks the people of Khumbu work hard; they are in the fields by eight o'clock in the morning and remain there until dusk; even the midday meal is cooked and eaten in the fields. Most young girls join work gangs, which labour in turn in the fields of the gang members, and all those who can afford to do so hire daily labour. Labourers are indeed so sought-after at harvest time that the wage offered is more than double that paid during the planting and sowing season, and the many Tibetans who come every year to Khumbu to help with the harvest find ready employment.

There seems to be a psychological difference in the Sherpas' attitude to the harvesting of grain crops and that of potatoes. While the potato harvest is mostly left to women and paid daily labourers, the richest man is not ashamed to help with the reaping of barley or buckwheat.

These two crops, barley and buckwheat, are undoubtedly the oldest food crops of Khumbu, for potatoes came to Khumbu only during the last century. Of the circumstances of their introduction little can be learnt, but it is probable that the earliest potatoes known in the Himalaya were grown in the gardens of the British planters and officers in Darjeeling and spread from there to Khumbu, whence they were brought by returning Sherpas. Most Sherpas of this generation know nothing of a time when there were no potatoes in Khumbu, but I was told by a fifty-year-old man of Phortse that as a child he had met a very old man who claimed to be the first to bring potatoes to the valley of the Imja Khola. These potatoes are said to have been very small and round, but at a later date an oblong yellow type arrived; this type is still extensively cultivated in Pangpoche, where it is esteemed for its excellent taste. Some fifteen years ago a third variety was introduced. This was a large round type of more prolific growth and it is no doubt on account of this quality that it is now grown in Khumbu almost to the exclusion of other kinds. In view of the fact that potatoes in one form or another are eaten at every meal, it is difficult to imagine the diet of the Sherpas before they had potatoes. Buckwheat and perhaps barley must then have had a greater importance, and it may be that in those days the number of families who cultivated food crops was smaller.

The arrival of the potato in Khumbu can certainly be linked with greater agricultural production and subsequently with a growth of population. From documents in the possession of the village elders it appears that in 1836 there were only 169 householders in the whole of Khumbu. Today the occupied houses number 596 and this considerable increase can only be explained by a sudden improvement in the economic position. As this coincided with the introduction of the potato we can hardly escape the conclusion that it was this new crop which revolutionized life in Khumbu.

How important the potato has become as the main food of the Sherpa is apparent from the requirements of a household of seven members: in 1957 this family consumed 6,000 lb. of potatoes, 320 lb. of buckwheat, 320 lb. of wheat, barley and millet and 160 lb. of rice. Here we should note that all grain, with the exception of buckwheat, has to be transported from areas lying lower than Khumbu.

While agriculture provides the Sherpas with the bulk of their food supply, the breeding of yak and other cattle allows them to supplement

their diet with milk products, and to engage in the profitable cattle trade that is transacted between Solu and Tibet. Khumbu, because of its geographical position and its climate and the availability of extensive high altitude grazing grounds, holds a key position in this flourishing business.

The character of the Sherpas' cattle economy is determined by the fact that the aim of most breeders is not only the maintenance and gradual increase of their herds, but the profits to be derived from the sale of calves. These profits are highest in the case of cross-breeds, and Khumbu where yak (*yak*, male; *nak*, female) and cattle of ordinary breeds thrive equally is in a favourable position to cater for the demand for cross-breeds both from Solu and from Tibet. As all male cross-breeds are infertile, breeders must maintain a stock of pure yak and pure bulls, and arrange for controlled mating between these two breeds. Successful mating of two breeds is more difficult to achieve than the spontaneous mating of animals of the same sub-species.

Cross-breeds are valued because they combine certain desirable qualities of both yak and ordinary cattle. Both males, *zopkio*, and females, *zhum*, are hardier and more sure-footed than oxen and can stand the climate of Tibet nearly as well as yak. Moreover *zhum* give more milk than *nak*, and *zopkio* are better pack animals than yak.

Apart from the cross-breeds, *zhum* and *zopkio*, which result from the mating of yak and cow, or *nak* and bull, there is also the issue of female cross-breeds mated with yak or bull. The following list gives the Sherpa terms for the various types of cross-breeds:

Bull + <i>nak</i>	= <i>dimzi</i> (male: <i>zopkio dimzi</i> ; female: <i>zhum dimzi</i>)
Yak + cow	= <i>urang</i> (male: <i>zopkio urang</i> ; female: <i>zhum urang-ma</i>)
Yak + <i>zhum</i>	= <i>tolmu</i> (male and female)
Bull + <i>zhum</i>	= male: <i>pamzo</i> ; female: <i>pamu</i>
Bull + <i>tolmu</i>	= <i>yir</i>
Bull + <i>yir</i>	= <i>ik</i>
Bull + <i>ik</i>	= <i>gar</i>

The value attributed to cross-breeds stands in direct proportion to the degree of yak or ordinary breed in their ancestry.

Though great care is taken to control the mating, some crosses occur which are not desired. The least profitable are those between bull and *pamu* or *tolmu*, for the male offspring are neither fertile nor hardy, and the female, though fertile, do not fetch good prices.

Yak are usually castrated when they are two or three years old, and most of the breeding is done with two-year-olds. If left uncastrated after that age they tend to become dangerous and their horns grow to a great length.

The best customers of the Khumbu cattle-breeders are the Sherpas of Solu. These come to Khumbu every autumn and buy young *zhum* and *zopkio* calves which are reared in Solu, where extensive natural grazing grounds are open throughout the year. While the Sherpas of Solu cannot themselves engage in this type of breeding because yak do not like the warmer climate of low altitudes, the Sherpas of Khumbu cannot rear all the calves they breed because they must reserve their winter fodder for the adult animals in their herds.

The Sherpas of Solu keep all *zhum* on account of their milk which is made into butter, a very profitable commodity. But *zopkio* are sold as two-year-olds to Tibet, Sherpas of Khumbu acting as middlemen.

Milk products play an important role in Sherpa diet. Fresh milk is not drunk in large quantities, except perhaps by lonely herdsmen having little else to eat, but curd is a highly valued food. Most of the milk is used for butter-making and in this respect no distinction is made between the thick, creamy milk of *nak*, and that of *zhum* or cow. Butter is made in a wooden churn, from milk which has been heated and then fermented with a little old curd. It is stored in leather bags and, nowadays, often in old kerosene tins.

Buttermilk is either drunk raw or thickened by long cooking over a slow fire. The resulting produce, resembling a stiff cream cheese, is considered a great delicacy both when eaten fresh and when dried in the sun to provide hard, long-lasting pellets used as nourishment on long marches.

The efforts of all cattle-owners are directed towards the production of butter. Great quantities are needed for domestic as well as for ritual use. Butter is eaten with, or as part of, the more highly valued foods; it is used as fuel in the butter lamps lit at all Buddhist ceremonies, and is moulded into various shapes for the decoration of sacrificial dough figures. Butter is also used as a medium for the payment of wages, and it forms an important article of trade in the Tibetan market. In Khumbu there is seldom a surplus of butter, and the majority of the butter exported to Tibet across the Nangpa La comes from Solu.

The second important product of yak is hair. Yak are shorn once a year, usually in June or July. Sherpas have no shears or clippers, and the scissors used by tailors are never employed for this purpose. The usual method of shearing yak is to take the long coarse hair by handfuls and cut it off with a razor-like knife. The finer hair is plucked, and at the time of year when the yak naturally lose their winter coat this comes out quite easily. Cross-breeds do not have long hair and are not shorn. Both types of hair are used for weaving textiles; the coarser for blankets and the finer for material which is made into clothes.

All animal hides are treated with salt and softened with butter. They provide soles for boots and have numerous domestic uses.

Though Sherpas are not supposed to kill animals they are not averse to eating the meat of animals which die by accident or are slaughtered by others. Professional butchers of *hyawo* class come once a year from Tibet for this purpose, and in 1957 there were two *hyawo* living in Namche Bazar. In the month of November when the pastures are bare and the Sherpas have already begun to feed their cattle with hay, yak between the ages of 15 and 21 years are slaughtered; the meat is eaten partly fresh and partly dried, being hung up under the roof, where during the cold winter months it keeps for a long time. The meat of animals killed accidentally during the warm season is cut up and smoked over fires. Sherpas have no prejudice against consuming the meat of animals who fall victim to wolves or leopards and any meat that can be recovered is unhesitatingly eaten. Only young calves which die from natural causes are not consumed by the owners, but are given to Khambas who seem to have no objection to eating this type of carrion.

Yak's blood provides the Sherpas with another type of food. The blood, drawn from the jugular vein of the living animal, is mixed with salt and left to coagulate. It may be eaten raw with *tsampa*, or cut into strips and fried.

Besides contributing milk, meat and blood for the Sherpas' diet, and providing hair for blankets and textiles, yak serve as the principle means of transporting goods. In the trade with Tibet they are used as pack-animals and in the seasonal migrations they carry a householder's belongings from settlement to settlement. *Yak*, *nak* and *zopkio* are all accustomed to carrying loads and the normal weight is between 100 and 120 lb. distributed in two packs. The animals are easy to handle and two men are sufficient to take a train of ten or twelve across the Nangpa La.

Notwithstanding the high prestige value of yak-breeding and its place in ritual, which is unparalleled by any comparable significance of agriculture, it would be misleading to think of the Sherpas as a predominately pastoral people. Whereas most Sherpa families engage to some extent in agriculture, yak-breeding is one of several economic choices, and there are many wealthy men who prefer to apply their energies to trade rather than to animal husbandry. Some idea of the place of yak-breeding in the economy of the Khumbu region can be gained from the cattle census which I compiled in 1957. Among the 596 families of Khumbu, only 254 owned animals, and while the population numbered 2,205, there were 2,894 animals.

The herds are concentrated in the hands of a few well-to-do families, and while less well-situated families may own one or two cows, yak are

only owned in herds with a minimum of six or seven head. In the village of Khumjung for example, the 347 yak are divided among 17 cattle-owners, while 16 families possess only a few cows. Consequently, of the 108 households of Khumjung only 17 are engaged in yak-breeding, which implies a limited number of owners of herd-huts, pastures and meadows on higher-lying ground. Those who own a few cows find enough grazing in the vicinity of the main villages, and it is only at the time when the crops are growing and all animals are forbidden to enter the village, that they must take their cows to nearby grazing grounds.

4. TRADE

The Sherpas' favourable position as middlemen in the trade between Tibet and the lower lying regions of Nepal has enabled them to attain a standard of living far higher than that of other Nepalese hill people, and in particular, that of their southern neighbours, the agricultural Rais. Though the latter dwell in country of milder climate and richer soil, they possess none of the luxury goods found in many of the more prosperous Sherpa houses, and have nothing to match the cultural achievements of the inhabitants of the cold, wind-swept highlands of Khumbu. It is the rewards of trade with Tibet which has given the Sherpas the opportunity to acquire valuable jewellery, clothing, household goods and ritual objects of Tibetan and Chinese origin; the many journeys connected with this trade keeps them in touch with the aesthetic and intellectual interests of their Tibetan neighbours.¹

Through Khumbu leads the trade route which links the rich agricultural lands of the Dudh Kosi basin with the Tibetan province of Tingri and the Sherpas of Khumbu have a virtual monopoly on the movements of goods from Namche Bazar across the Nangpa La to Kyabruk, the first Tibetan village, and Tingri. This monopoly, jealously upheld by the Khumbu Sherpas, has in the past been confirmed by an order of the Nepalese authorities which ruled that Sherpas of Solu were not allowed to trade direct with Tibet, except for the purchase of necessities for their own use. There were similar restrictions on the trading of Tibetans. They were allowed to bring their goods as far as Namche Bazar, but there they had to dispose of them to Sherpa traders, who arranged for their re-sale to the peoples living further south.

This trade, which is largely responsible for the prosperity of Khumbu, has undergone considerable changes during the past century. There was

¹ Since this was written the situation on Nepal's border has been radically changed by the Chinese action in Tibet, which led to the flight of the Dalai Lama. The following description of the Sherpas' traditional trade-relations with Tibet is based on conditions prevailing in 1957, and applies only in part to the present very restricted local trade.

a time when great quantities of raw iron, produced in the small Nepalese mining town of Thosé, were carried through Solu and Khumbu to Tingri. But since the construction of a motor road from the plains of Bengal to Kalimpong and Gangtok, cheap Indian iron reaches Tibet in such quantities that it has completely replaced the Nepalese product; no iron is now carried over the Nangpa La.

When the trade in Nepalese iron declined, the trade in Tibetan salt was still at its height, and many of the fortunes of the great traders of Namche Bazar were made by the import of salt and its re-sale throughout the lower regions of Nepal. Though salt is still one of the principal wares brought over the Nangpa La, the trade in Tibetan salt is operating on a shrinking market. Cheap and easily handled Indian salt imported from the south is gradually penetrating the markets of the middle ranges of Nepal, an area in which twenty years ago only Tibetan salt was known.

Tibetan salt is still used in the whole of Khumbu, Pharak and Solu and in the neighbouring areas inhabited by the Rai tribes and every year hundreds of sacks of salt are brought on porters' backs and on pack animals over the Nangpa La. Payment is in many cases made in cash, though often rice and other grain is offered in exchange. According to demand and supply, the Sherpa receives in Kyabruk, the first Tibetan settlement on the other side of the Nangpa La, seven to eight measures of salt for every four measures of rice and in Tingri the rate rises to nine or ten. For this type of barter trade the Sherpas buy the rice they need from the Rais in whose villages they can exchange a measure of salt for three times the amount of rice. Such transactions do not only entail a six days' return journey over the Nangpa La, but an even longer journey into the rice-growing areas south of Pharak. In addition to rice many Sherpas take maize and millet to Tibet. This is obtainable in Kari Khola, three days' march from Khumbu, and may be traded at a rate of four measures of maize or millet for one measure of salt. Maize when transported as flour, which is ground in one of the water mills of Khumbu, is sold for a double quantity of salt.

Tibetan wool is also imported in large quantities. In Khumbu few sheep are kept and Sherpa women are largely dependent on Tibetan supplies for the manufacture of textiles for clothing. Most families organize an expedition to Kyabruk or Tingri every autumn, in order to lay in a stock of wool which the women have time to spin and weave during the long winter months. Even young girls go with their brothers and friends on these journeys and do not hesitate to carry loads of wool weighing anything from 70 to 100 lb. over the Nangpa La to Khumbu.

This type of trading in salt, grain, wool and other commodities is in the hands of small traders, who carry the loads themselves and require

the goods for their own consumption. Large-scale traders used to transact business through the medium of Nepali, Indian, Tibetan and Chinese currency; they employed trains of pack animals to transport their wares and operated in areas as far apart as Shigotse, Lhasa, Darjeeling and even Calcutta. The merchandise imported into Khumbu included not only salt and wool, but certain types of finely woven textiles, Chinese silks and brocades, and from the oldest times such luxury goods as porcelain cups, carpets and various types of valuable jewellery. Goods exported to Tibet included hides, hand-made Nepali paper, dyes of every description, goods of diverse origin from India such as sugar and cotton cloth; the most important items were, however, grain and butter and above all cattle. The volume of the cattle trade and the investment of capital it entails is demonstrated by the following example. In 1956 a trader of Namche Bazar bought 140 *zopkio* in Solu, took them to Tibet and stayed there until they were sold. He returned to Namche Bazar after a few months with 16,000 rupees in cash and a considerable quantity of Tibetan goods.

Trade as conducted by the big merchants of Khumbu calls for elaborate organization, long-standing personal contacts in Tibet, India and Nepal and great personal enterprise. Many trade deals involve long-term credit, and personal prestige and trustworthiness are often the only security offered. Some of the traders of Namche Bazar are wealthy by Nepalese standards, but the risks are great; herds may perish by disease, trading partners may abscond and no trader is secure against a series of reverses which may turn even the richest into a poor man within a few years.

It is to be feared that the present political situation in Tibet will unfavourably affect the sherpas' vital trans-border trade. While the exchange of salt for rice and other grain may continue for some time, Tibetan salt being unsaleable in any other market, there are already signs that Tibetan wool is being bought up by the Chinese for transport to areas other than Khumbu. For the Sherpas of Khumbu, who use this wool for their own requirements, the drying up of their source of supply could have very serious consequences.

5. CRAFTS

Among the Sherpas of Khumbu there are only a few people who are recognized as specialized craftsmen. The majority of men and women are apt at various crafts, but only utilize their skills within the framework of their own family economy. All men and women can spin and even wealthy men will spin while talking to friends and acquaintances.

Weaving is women's work. There are some women who have never learnt to weave but the majority spend a great deal of time at the loom, making textiles not only for home consumption but also for sale. Poorer women often engage as daily workers in the houses of well-to-do villagers and there are several workshops which have a considerable annual output. The Sherpas use a pedal-loom of Tibetan type to weave textiles for clothes and aprons, but yak hair mats and blankets are woven on primitive looms of the so-called Indonesian type; these are secured to the waist of the weaver and rolled up when work ends. Textiles of all kinds are woven in narrow strips, which are sewn together to give the required width. The characteristic many-coloured aprons worn by women are woven of cotton and wool and individual weavers have ample scope to express their personal taste in the choice of colour combinations. In many families clothes both for men and women are made at home, but there are several professional tailors who will come to the houses and work for a daily wage and food during the time of employment.

Even greater is the specialization of the boot-maker. Although most men are able to re-sole their boots and it is customary to take spare soles on any long journey so that repairs may be carried out *en route*, only a few men are able to make a new pair of boots. In most villages there are professional boot-makers who sell ready-made boots, but will also come to a customer's house and make boots out of materials provided. Though without exception Khambas of Tibetan origin they cannot make the most expensive type of boots, which have rope instead of leather soles and are richly embroidered. Such boots are imported from Tibet.

In every Sherpa village there are one or two carpenters, and when a house is being built the employment of such skilled artisans is indispensable, even if the rest of the work is done by the householder and voluntary workers, who tender their help on a reciprocal basis. Carpenters receive a daily wage roughly double that of tailors and shoemakers, a rate of pay that is considered commensurate with the importance of their task and the strenuousness of their labour. They also make benches, tables, bedsteads, boxes, shelves and numerous other articles for domestic use, as well as such implements as looms and ploughs. Yet few carpenters devote themselves exclusively to their craft and most of them spend part of their time farming their lands and tending their herds.

Among Sherpas there are no blacksmiths or other metal workers, but a few families of blacksmiths and silver workers of Kami caste have settled in Namche Bazar. They belong to one of the untouchable Hindu castes, speak only Nepali and stand outside Sherpa society. They are useful in supplying the people of Khumbu with iron implements, and

some of them are skilled in making silver cups and stands and covers for porcelain tea cups, as well as ornaments of beaten gold. The Sherpas pay for these services in cash, or more frequently in agricultural produce, especially potatoes. While Sherpa society does not recognize 'untouchability' these Kami blacksmiths retain in Namche Bazar the depressed status accorded them in the Hindu society of their original environment. They do not enter Sherpa houses and there is neither inter-marriage nor inter-dining between Kami and Sherpa.

No pot-making takes place in Khumbu, and such pots as the Sherpas require have to be brought from regions of lesser altitude. But the use of earthen pots is limited; Sherpas cook mainly in iron pans, use copper and brass vessels for storing and wooden pails for fetching water.

In Khumbu there is only a limited occupational specialization according to crafts. The Sherpas do not share the Nepalese Hindus' attitude to certain types of manual work. Except for such activities as slaughtering animals, which is sinful for the strict Buddhist, there is no occupation a Sherpa would consider polluting or demeaning. Prosperous men of good social status will on occasion do their own carpentry work, tailor their own clothes, cure yak hides and repair their own boots. Only in those fields where special skills have to be acquired by a great deal of practice is there some scope for professional craftsmen. Thus the boot-maker or expert carpenter provides services which are beyond the ability of the ordinary householder, and in this respect his role is not different from that of the carver in stone employed to carve the sacred formula, *Om mani padme hum*, into a rock-face or of the painter commissioned to paint frescoes in temples or private chapels. Neither is the boot-maker despised nor the painter particularly honoured, except in so far as the latter's knowledge of the scriptures—a knowledge which is necessary for the practice of an art devoted almost entirely to religious purposes—entitles him to the respect of the community.

In recent years a novel type of specialization in the shape of work for mountaineering expeditions has offered to poor and energetic young men new chances of economic gain. Normally a Sherpa without land or capital cannot hope to attain more than a modest prosperity even by a lifetime of hard work. The structure of Sherpa economics favours the entrepreneur rather than the wage-earner, and for the impecunious many years of working in the pay of others must precede the acquisition of land and cattle, or the first steps as an independent trader. But the successful high-altitude porter may return after a single season's climbing with sufficient cash to set up his own business or to buy his first plot of land.

The sudden affluence of those who engage in expedition work has brought to the fore a class of men who were used to living in the shadow

of families whose status was backed by inherited wealth. This has created a situation which may well result in far-reaching social and economic changes. On the whole it can be said that the porter element has not yet displaced the members of the traditional status groups who provide the leadership of the villages, for the rest of the community tends to view with some suspicion a sudden rise to prominence which is dependent on spheres outside the framework of their traditional culture. Moreover long years of work for expeditions tend to develop egocentric attitudes in the individual which accord ill with Sherpa ideals of behaviour. That the earnings from work on mountaineering expeditions has been beneficial to many families of Khumbu cannot be doubted, but the prolonged absence of young men from Khumbu has resulted in a vacuum which can only be filled by immigrant labour from Tibet.

6. THE STRUCTURE OF SOCIETY

All Sherpas share the tradition of having immigrated from Tibet but the circumstances and time of this migration are obscure. While the subsequent arrival and miraculous feats of various lamas are the subject of numerous legends, traditions and myths relating to the Sherpas' migration to the regions of Khumbu and Solu and of the establishment of the present villages are almost completely lacking. This dearth of legendary as well as historical accounts of their ancestors' arrival in their present habitat is all the more surprising as many Sherpas are literate and well acquainted with myths and traditions regarding the establishment of Buddhism in Tibet and the details of the lives of such legendary personages as Guru Rimpoche and Pawa Chereze.

Of their own ancestors, on the other hand, they know next to nothing, and there is no agreement even on the route of migration which led them from Tibet to Khumbu and Solu. Most Khumbu Sherpas believe that their ancestors migrated south along the Rongshar Chu—west of the Rolwaling Himal—and then turning east, settled first in Solu, where they ousted an earlier Kiranti population. From Solu they moved—according to this tradition—northwards into Khumbu; but a contradictory belief is expressed in the view that the ancestors of certain clans came to Khumbu straight from Tibet, crossing the Nangpa La and using the main trade route that links Khumbu and the Tingri region.

There is, however, fairly general agreement that the ancestors of all Sherpa clans (*rhu*) arrived in the area at approximately the same time and that ever since the number of clans has remained constant. None of these clans lays claim to seniority or higher status on the grounds of prior arrival in Solu and Khumbu, nor is the numerical predominance

of the one or other clan in any specific area considered a significant indication that its members were the first to settle there.

In some villages there is a vague tradition that the members of certain clans were the original settlers in the locality, but this belief does not find expression in ritual or social behaviour. Indeed, the idea that historical claims should be reflected in present-day rights is foreign to Sherpa thought, and this attitude accounts perhaps for their scant interest in the past both of the Sherpa people as a whole and of individual groups.

There is nevertheless a widespread notion that the number of clans or *rhu* constituting the Sherpa society in Khumbu, Pharak and Solu is eighteen. Not all Sherpas are able to enumerate as many as eighteen clans, while a list comprising all the clans represented in the various villages of this region runs to the following twenty-one names, arranged here in alphabetical order: Chiawa, Chusherwa, Gardza, Gole, Goparma, Jongdomba, Khambadze, Lakshindu, Lama, Lhukpa, Mende, Munming, Nawa, Paldorje, Pankarma, Pinasa, Salaka, Shangup, Sherwa, Shire, Thaktu.

Some Sherpas explain the discrepancy between the traditional figure of eighteen and the actual number of clans found at present by pointing out that several clans, though known by different names in different regions, are really identical. Thus the Paldorje and Salaka people are said to constitute one clan, known as Paldorje in Khumbu and as Salaka in Solu. Others explain the special relations between such clans, whose members are debarred from inter-marriage, by saying that they are brother clans.

Apart from these comparatively few groupings of clans on the basis of a traditional brother-relationship, there is no principle according to which the various Sherpa clans can be brought into any specific order. No clan claims seniority or privilege, and there is no significant territorial distribution.

The essential feature of the Sherpa clan is its role as the basic exogamous unit. All Sherpas of the same *rhu*, irrespective of the distance which may separate their villages and the impossibility of tracing consanguinity, consider themselves as agnatic kin and debarred from marriage. Sexual relations between clan-members are regarded as incest, and are virtually unheard of. Though there is a great tolerance of casual sex-relations, both pre-marital and extra-marital, I have failed to discover a single case of even a fleeting amorous attachment between members of the same clan, and all my informants were emphatic in expressing the view that dire punishment would be meted out to anyone offending against the rules of clan-exogamy.

While Sherpa clans have no corporate existence in either the economic

or the political field, they do appear as distinct units in a limited number of ritual matters. Thus the members of every clan recognize certain mountain-gods as their specific protective deities, and on some occasions clan-members resident in the same village may combine for the worship of such clan-deities.

The main occasions for the worship of the clan-deities are the three *labetu*, namely the So-lha in the month of May, the Yerdzang in the month of August, and the Ten-lha in the month of October. As the Yerdzang is performed at a time when yak-owning families are dispersed over a number of summer-settlements (*versa*), there is at that festival no occasion for a gathering of clan-members. But at the two other *labetu* the members of a clan resident in a village may gather in the house of a senior clan-member and co-operate in the act of worship.

Whereas membership of a Sherpa clan does not involve any definite obligations other than the observance of the rules of exogamy and the worship of the clan-deities three times a year, it is of supreme importance as an indispensable symbol of a person's status within the inner core of Sherpa society. For in Khumbu, Pharak and Solu only members of the twenty-one clans listed above are considered true Sherpas, and only they have a clear place in the exogamous system. Numerous other inhabitants of the region, closely akin to the Sherpas in language and customs, and largely indistinguishable from them in appearance, are known as Khambas, and regarded as socially slightly inferior to the original Sherpas.¹

Most of these Khambas are recent immigrants from Tibet, and it is somewhat illogical that the Sherpas, who themselves claim descent from immigrants of past ages, have nevertheless the tendency to look down upon those who have only been settled south of the Great Himalayan Range for the last one or two generations.

Yet, for all practical purposes, these Khambas form part of Sherpa society. They can acquire land and houses, and marry into Sherpa families, be elected as village officials, function as lamas and attain even the highest positions in any of the local monasteries. But despite all these privileges Khambas can never become part of what is traditionally the core of Sherpa society. They can neither acquire membership of Sherpa clans, nor do they have comparable exogamous units of their own, which could be added to the list of Sherpa clans and thus lead to a gradual expansion of the Sherpa clan-system.

As a rule no distinction is made between different types of Khambas,

¹ Throughout sections I-V the term 'Sherpa' has been used with reference to the entire population of Khumbu, and a difference between 'Sherpas' and 'Khambas' is emphasized only where a distinction between these groups is socially relevant.

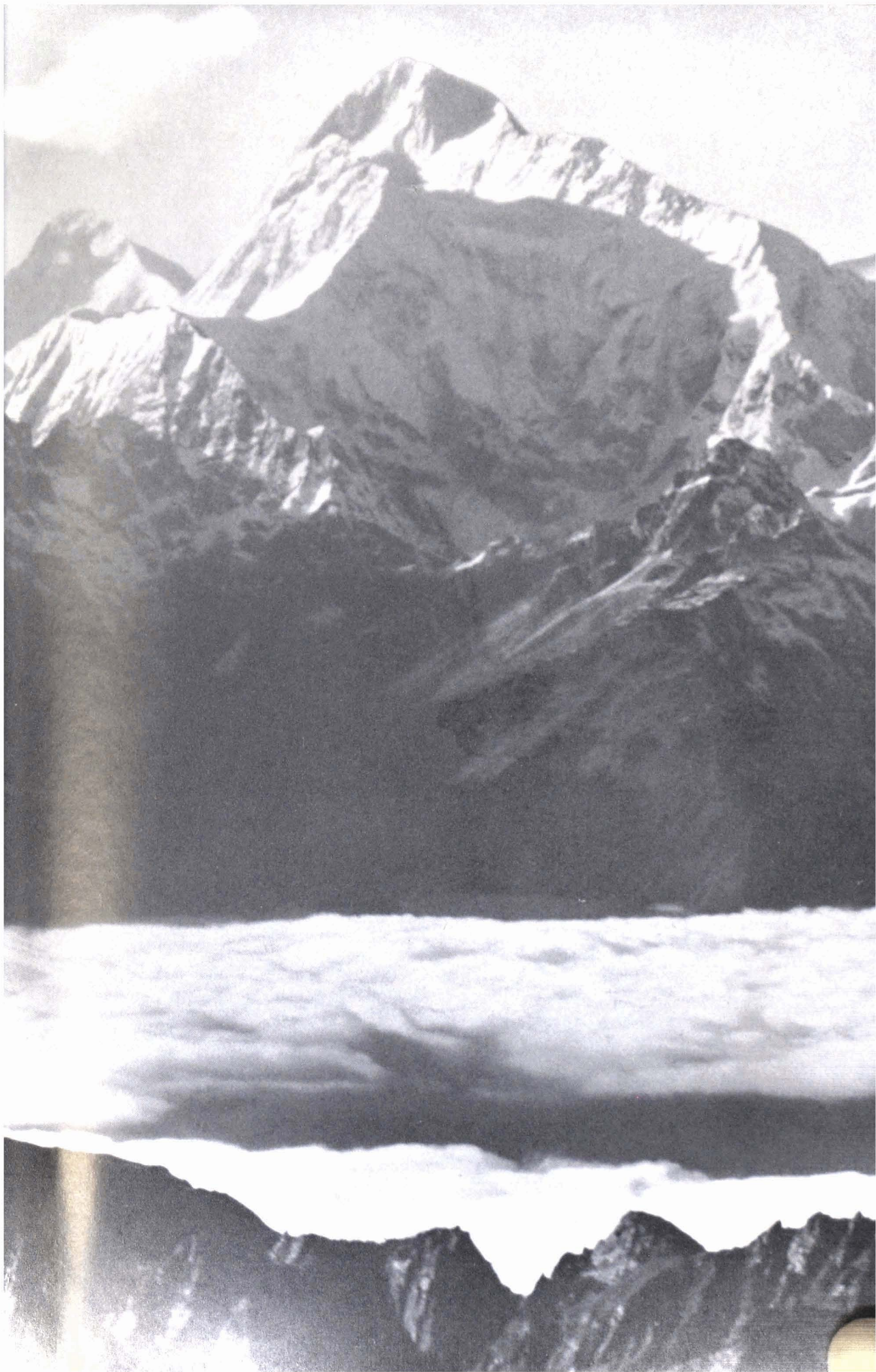
this blanket term being applied to all who either came from Tibet in their own lifetime, or who are descended in the male line from such immigrants. Strictly speaking Khambas are only those who hail from the Tibetan province of Kham, while those from the nearby frontier-regions of Tibet should be described as Pheipas. But the term Pheipa is seldom used.

The practice of referring to anyone who is not a member of a Sherpa clan as 'Khamba' extends illogically even to certain Gurungs and Newars who have settled in Khumbu and inter-married with the local population. Some of these have reached Khumbu by way of Tibet, and Sherpas say that in their eyes anyone coming from Tibet is a 'Khamba', whatever his origin. The most prominent painter of Khumbu, for instance, is the son of a Gurung father and a Sherpa mother, but as the father came to Khumbu after practising the art of painting in various Tibetan monasteries, the son is loosely referred to as 'Khamba' although everyone is well aware of his Gurung ancestry. Similarly a Newar of Namche, whose father came from Patan and whose mother is believed to be a Tibetan is also described as 'Khamba' for he reached Khumbu by way of Tibet.

While the core of Sherpa society, consisting of a limited number of exogamous agnatic clans, shows a high degree of constancy, the total society of Khumbu exhibits a remarkable power of absorption. Round the permanent core are arranged numerous accretions, which in some villages account for as much as half the population. Immigrants from Tibet, whose numbers seem to have greatly increased within the last two generations, are responsible for the greater part of these accretions, and in villages such as Khumjung and Kunde forty per cent of the households are those of Khambas. Diagrammatically these accretions to Sherpa society can be represented by concentric rings arranged round the core according to the relative times of arrival in Khumbu. Those Khambas who have been settled in Khumbu for several generations are represented by a ring set closest to the core, and each successive ring represents a new wave of immigrants. Minor sections of these rings correspond not to Tibetan immigrants but to Gurungs, Newars and the descendants of other non-Sherpa settlers in Khumbu.

No section of the diagram represents a water-tight compartment comparable to the strata of a caste society. Though no new agnatic clan can be added to the core, fresh blood is continuously being introduced into it by marriages between men of Sherpa clans and women of immigrant families. Similarly women of Sherpa clans marry out into the one or other of the marginal rings. As a rule inter-marriage is more frequent between those sections of the society represented in the diagram by immediately adjacent sections than, say, between members of the

PLATE 26. The enormous pyramid of Makalu, 8470 m. (*centre*) and Lhotse, 8501 m. (*left*). This is probably the greatest difference in altitude in the world in such a small area. The cloud bank is at about 3000 m., the Arun Gorge below is only 1300 m. The low dark peak to the right is much higher than the Matterhorn





traditional Sherpa clans and the most recent arrivals represented by the outermost ring. Strict adherence to the patrilineal principle in determining a person's position in this system prevents the addition of new lineages to the core, but inter-marriage between different sections has resulted in the gradual blurring of social distinctions between the families of true Sherpa stock and the descendants of Khambas or other newcomers.

In villages such as Khumjung and Kunde no Khamba family has as yet risen to a position of wealth and influence equalling that of the more prominent Sherpa families. In the trading community of Namche Bazar, on the other hand, where social status is directly correlated with wealth, there are several rich Khambas among the leading men of the village, and prejudice against Khambas seems to be very much less pronounced than in such long-established villages as Khumjung.

The introduction of Gurung, Newar and Chetri blood into Sherpa society is almost entirely due to marriage or casual intercourse between men of these communities and Sherpa women; their children and grandchildren are the Gurung, Newar or Chetri Sherpas we find today in several villages. Culturally and linguistically they are indistinguishable from other Sherpas, but their mixed parentage is sometimes apparent from their physical characteristics. Within the last two or three generations there seems to have been no case of a Sherpa man marrying a Gurung, Newar or Chetri girl.

The admixture of Gurung, Newar and Chetri blood is, however, negligible compared to the recurrent absorption of large numbers of immigrants from Tibet. Throughout the late spring, summer and early autumn of every year there is a continuous traffic of men and animals along the route which leads over the Nangpa La from Tingri and Kya-brak in Tibet, past the village of Thami, to Namche Bazar. Along this path come not only traders with their merchandise but also small bands of Tibetan families, often consisting of a couple and their small children, and carrying—as some Sherpas contemptuously say—nothing but ‘a basket and a stick’. These immigrants are almost invariably poor people who have been attracted by stories of ample employment for seasonal labourers, plenty of food, and a higher standard of living. Sometimes they may carry with them a few pieces of woollen material or some dried meat, which during the first days in Khumbu, they may barter for food and shelter. But hardy and resourceful as the poorer Tibetans are, they usually have little anxiety as to the manner of supporting themselves, nor are they too proud to go with their basket from house to house, begging handfuls of potatoes from every Sherpa family. The avowed intention of most of these immigrants is to find work, and if possible a new home, in one of the villages of Khumbu. Many Tibetan families

PLATE 27. A Sherpa weighs the sacrificial cakes made of barley meal and butter (*torma*). These are used at an annual rite celebrated in the high mountain pastures

have succeeded in this aim, and the numerous first, second and third generation Khambas in villages such as Khumjung and Kunde are evidence of the continuity of this process of gradual infiltration.

With the hundreds of Khamba families already established in Khumbu, the new arrivals often have kinsmen or friends who will help to smooth their first steps in a new environment. The problem of shelter is in most cases easily solved. In many Sherpa houses there are unused ground floor rooms, and a Khamba usually obtains permission to occupy such a windowless store-room in return for help with the work on the fields or the cutting and bringing in of firewood. During the time of planting and sowing, and again during harvest many Sherpa families are short of hands, and Khambas have usually no difficulty in finding employment as agricultural labourers. Many Khamba men are, moreover, skilled in boot-making and tailoring, and the women know how to weave and spin. The wealthier Sherpas are often in need of helpers possessing these skills, and it is not unusual to see newly arrived Khambas busily sewing boots and clothes in a Sherpa house where they are fed in addition to receiving a daily wage.

It goes without saying that not all Tibetans coming to Khumbu succeed in establishing themselves in a village community and there are many who return to their homes after having worked in a Sherpa village for a few weeks or months as seasonal farm-hands. Yet, the number who make good and remain in Khumbu is appreciable. In Khumjung and Kunde alone there are thirty-four Khambas who have arrived in their own lifetime, and are now more or less permanently settled. No less than twenty-one of these now own houses and cultivate plots of land, and some of the second generation Khambas have acquired considerable wealth.

Work as porters in the service of mountaineering expeditions have offered to many Khambas new possibilities of employment and many Khambas owe the basis of their capital, which has enabled them to invest in trade or cattle-breeding, to their success as high altitude porters. The most famous of these is Tenzing, the climber of Mount Everest, whose Tibetan-born parents settled in Khumbu, and who as a young man was himself in the employ of well-to-do Sherpas.

The Sherpas' attitude to the Khambas who have settled among them is of considerable complexity. On the one hand there is the widespread feeling that Khambas are basically inferior to Sherpas, and this sentiment finds expression in many a loose generalization on Khamba character and behaviour. As most Khambas arrive in Khumbu as paupers their standards of honesty are as a rule much lower than those of the comfortably settled Sherpas. Such petty thefts as occur in Khumbu are usually committed by Khambas, and Sherpas are no doubt justified in doubting

the trustworthiness of seasonal workers and new arrivals, who live from hand to mouth and have very little to lose. Similarly there is the belief that Khambas are particularly loose in sexual morals, and that men and women of Tibetan origin are more prone to live together without having gone through any marriage ceremony than the old inhabitants of Khumbu. This idea too seems to be based on fact. First generation immigrants often do not bother to incur the expense of formal wedding ceremonies, and both men and women are inclined to change their partners without much ado.

When talking among themselves, Sherpas will often refer to Khambas in derogatory terms, and in the course of a quarrel even the most respectable Khamba may be told to his face that he or his father arrived in Khumbu as a pauper, carrying nothing but a stick and a begging basket. And when discussing any less-than-commendable behaviour among recent immigrants, Sherpas will often shrug their shoulders, remarking: 'What, after all, can you expect of Khambas?'

The relationship of Sherpas and Khambas has its positive as well as negative side. Many rich Sherpas could not cultivate all their lands or carry on their trading business were it not for these hard-working immigrants from beyond the Nangpa La. However much scorn some Sherpas may occasionally heap on Khamba habits, there are few who would like to see even the first generation immigrants depart in a body from Khumbu.

Many a pretty Khamba girl marries a Sherpa husband and so it is that some well-to-do Sherpas have Khambas among their nearest relations; the consciousness of these ties of consanguinity and marriage prevents such men from expressing any general prejudice against Khambas. While a feeling of superiority colours most Sherpas' attitude towards the first and second generation immigrants from Tibet, there are a few wealthy Khamba families settled for several generations in Khumbu which for all practical purposes are considered the equals of Sherpas. The young abbot of Tengpoche is the son of undistinguished Khamba parents of Namche Bazar, but as a reincarnation of the founder of Tengpoche, and the present head of the monastery, he is treated with a veneration such as only the greatest of lamas are accorded.

While there are no status differences between any of the Sherpa clans, there is among the immigrants from Tibet a class of people considered inferior by other Khambas and, no doubt in consequence of this imported distinction, also by Sherpas. People of this inferior class are referred to as *Khamendeu*, which means literally 'mouth-bad', an expression associated with the refusal of people of superior class to drink from a vessel touched by the mouth of any person of *Khamendeu* status. The opposite to

Khamendeu is *Khadeu* or 'mouth-good', and other Khambas and all Sherpas are thus described in relation to people of *Khamendeu* class. The discrimination against *Khamendeu* does not go as far, however, as the ban on inter-dining between Hindu castes, for persons of *Khadeu* status may freely eat the food cooked and served by *Khamendeu* and the only restriction placed on commensality is the rule that those of *Khamendeu* class may not drink from the cup which passes in usual Sherpa fashion from mouth to mouth.

Inter-marriage between *Khadeu* and *Khamendeu* is forbidden and a *Khadeu* who entertains sexual relations with a *Khamendeu* loses his or her *Khadeu* status and is henceforth treated as *Khamendeu*. Casual breaches of the rule can be expiated, but permanent associations lead to a loss of *Khadeu* status. The children of any mixed union rank as *Khamendeu*.

Apart from the Khambas of *Khamendeu* status, there is another category of people who suffer similar social handicaps. These are known as Yemba, a Sherpa term synonymous with the Nepali Gharti. Yembas or Ghartis are released slaves or persons of slave-descent. Throughout Nepal slavery was officially abolished in 1926, but the freed slaves and their children are still accorded very low status, and the same restrictions apply to them as to the Khambas of *Khamendeu* class. Though Yembas rank according to general belief even lower than *Khamendeu* Khambas, there is no restriction on commensality and inter-marriage between persons of these two low-status groups.

Though *Khamendeu* Khambas and Yembas are clearly inferior to *Khadeu* Khambas and Sherpas, and there is no machinery by which they could improve their status, they are not excluded from the social and ritual life of a Sherpa village, and can even occupy official positions at temple feasts. Sherpas do not hesitate to accept hospitality in *Khamendeu* houses and they invite *Khamendeu* and Yemba men, women and children to their own festivals.

The attitude of the Sherpas to the members of the two low-status groups illustrates that sentiments based on class are alien to Sherpa society. The absence of any feeling comparable to the caste-consciousness of Nepal's Hindu society, and even the present-day Buddhist society of the Nepal Valley has facilitated the absorption of various alien ethnic elements into the body of Khumbu society. Even the status differentials between Sherpas and Khambas are not great enough to impress the superficial observer, and in the whole of the mountaineering literature there is no reference to Khambas. We may then conclude that the population of Khumbu, Pharak and Solu constituted a basically open society which stands in pronounced contrast to the closed caste-societies of other parts of Nepal. The comparative ease with which members of neigh-

bouring populations can be absorbed and assimilated recalls a similar flexibility apparent in certain tribal societies which have remained untouched by the influence of Hindu caste concepts. Buddhism in its Tibetan form has allowed such tribal characteristics to persist, and it would seem that the Sherpas combine the basic features of a tribal society with the consciousness of actively sharing in the great civilization of Tibetan Buddhism. This participation in the civilization of a wider society finds its expression above all in the close relations between Sherpa and Tibetan monasteries, and the great number of Sherpas who study at Tibetan centres of learning. Sherpa lamas and monks feel at home not only in Rongphu, but even in such distant places as Shigatse and Lhasa, and the frequent contacts between Tibetan and Sherpa lamas are a continuous source of inspiration to the religious institutions of Khumbu and Solu.

7. VILLAGE ORGANIZATION

A Sherpa village is a territorial as well as a political and ritual unit. Though the majority of the householders reside within the limits of the village for less than half the year, it is nevertheless at the level of the village community that the integrating forces of Sherpa society operate. Neither the clans, extending throughout the whole of the Sherpa country, nor the territorial groups of villages based on regions such as Khumbu and Pharak, which share like customs and an environmentally conditioned pattern of life, cohere in the exact sense that mutually dependent parts combine in organized and concerted action.

The households of a village constitute a community of closely integrated families, many of whom are linked by ties of kinship and affinity; it is a community which is capable of concerted action aimed at the preservation of its natural resources, the maintenance of law and order and the performance of ritual activities designed to further the material and spiritual well-being of the community as a whole.

Far removed from the centres of state and district administration and rarely visited by touring officials, Khumbu enjoys a measure of *de facto* though not *de jure* autonomy, and this has allowed its inhabitants to organize their life with a minimum of interference. The delivery of a modest land-revenue through their own representatives to the government treasury at Okhaldhunga, some six days' march away, is their only positive obligation towards the State. Though there is a police outpost in Namche and cases of crime fall under the jurisdiction of the Magistrate's Court at Okhaldhunga, a whole year may pass without any such case being reported or any Khumbu Sherpa seeking the assistance of the legal machinery of the State.

Such disputes as arise between villagers or members of two villages are usually settled locally, and no outside authority intervenes in the internal affairs of the villages of Khumbu. The control of these affairs lies in the hands of a number of annually elected village officials, and a system of authority whereby the burden of public office passes in turn from one householder to the other engenders a sense of civic responsibility and a remarkable degree of discipline *vis-à-vis* matters affecting the common good. This civic sense is demonstrated not only by those Sherpa families who have been settled in a village for many generations, but is a pattern of behaviour to which even the more recent Khamba immigrants conform, for social recognition as a member of the village community can only be gained by the gradual assumption of a share in the discharge of public duties.

The system of village administration is based on the principle that all authority is delegated to officials elected for limited periods and though during their term of office they are guided by decisions of policy made by public gatherings, they are not responsible to any superior body for the day to day administration of agreed rules. They are empowered to inflict and collect fines as well as to grant exemption in case of individual hardship. The village community as a whole cannot correct the actions of its officials; it can only express disapproval of them either by refusing re-election or by withholding future appointment.

There are several types of village officials and the functions of each are strictly circumscribed. The settlement of disputes that pertain to social relations is left to private mediation, and the inability—or unwillingness—of the village community as a whole to assume authority in dealing with such matters, is one of the peculiar features of Sherpa social organization. Here we will deal not with the aspects of social life that lie outside the intervention of institutionalized authority, but with the functions of those officials responsible for activities subject to the community's overt and organized control.

In every Sherpa village of Khumbu men known as *naua* are appointed to control the use of village lands for purposes of agriculture, silviculture and cattle-breeding. Their function is to hold a balance between the needs of these branches of Sherpa economy, to husband the communal resources and to prevent damage to the interests of the community by the careless or egotistic behaviour of individuals.

The appointment of one type of *naua* is made before the O-sho, a rite designed to encompass the village and the cultivated lands with magical frontiers, from within which all evil and malignant forces are excluded. The O-sho takes place in the early part of May, a time coinciding with the germination and sprouting of the crops. The new *naua*

arrange for the performance of the ritual and it is owing to this association that they are described as O-sho *naua*. Soon after their election they summon the villagers to a meeting known as *yül-thim* (village-law). At this meeting decisions are taken that prescribe the movements of the herds during the ensuing season. It is customary to exclude all cattle from the limits of the village lands during the summer months lest straying animals damage the growing crops and the *yül-thim* fixes the date after which no cattle must remain in the village; this is generally a stated number of days after the Dumje festival, a rite which all villagers must attend. At the same time the *yül-thim* decides which pastures will be open and which closed to cattle during the coming grazing season. These decisions are recorded in a written document, which is handed to the *naua* whose duty it is to administer the rules as agreed by the village assembly; they are entitled to fine those who have not removed their yak, oxen, sheep or goats from the village by the date decreed and in extenuating circumstances they can extend the time-limit by a few days; they can also allow an animal with a broken leg to be kept in the village throughout the prohibited period. Pack animals arriving from Tibet or from high altitude settlements may remain in the village for one night in transit, but anyone exceeding this period is fined by the *naua*. After the annual exodus of the cattle the *naua* build a wall that closes the path leading to the high pastures; the breaking of the wall after harvest, an act which denotes the end of the cattle's exclusion from the village, is also the duty of the *naua*.

The fines collected by the O-sho *naua* during the cultivating season—and it is only during this season that they wield authority—are paid either in beer, which is consumed by the *naua*, or—in all but trivial cases—in cash. Such cash fines are used for the upkeep of the village temple or for other public works.

Besides the *naua* responsible for the control of the movements of the cattle and their co-ordination with the work on the fields there are in every village officials in charge of the preservation of the tree growth on the common lands of the village. These officials are also known as *naua*, but as they deal with the husbanding of the community's wood and timber resources, they are referred to as *shingo-naua*, *shing* being the Sherpa word for wood.

The *shingo-naua* are appointed every year; though the term of their office is usually twelve months, *shingo-naua* who have proved efficient and are popular may be confirmed in office over a number of years. Two to four *shingo-naua* are appointed for each village, the number being dictated by local conditions, i.e. by the size of the village and the extent of lands to be protected; the number must, however, be sufficient to

allow them to exercise a continual vigilance and thus to prevent woodcutters from encroaching on the protected areas. It is within the competence of the *shingo-naua* to permit limited fellings for specific purposes such as house-building, and they do not interfere with the cutting of wood required for funeral pyres. Firewood must be brought from more distant areas and during their term of office the *naua* are entitled to check woodstacks if they suspect that these contain wood taken from prohibited areas.

The fining of offenders takes place annually soon after the O-sho rite when the *shingo-naua* call the villagers to a meeting at the public assembly place. At this meeting all those guilty of forest offences during the previous year must bring a bottle of beer and admit their guilt publicly. If the offence is of a minor nature, such as the cutting of a few green branches in an area where only dead wood may be collected, the beer is accepted as adequate recompense, but cash fines are imposed for more serious breaches of the law. The beer brought on this occasion is known as *shingi-na-chang* (wood-beer). It is immediately consumed by the assembled villagers, and under its mollifying influence the atmosphere of the meeting rapidly changes from one of a village court to that of a village festival.

Shingo-naua, like O-sho-naua, derive their mandate ostensibly from the assembly of villagers, but in fact their appointment is the outcome of consultations within a comparatively small group of influential men.

Though not every village possesses a temple of its own, every village participates on equal terms in the festivals celebrated in the temple to which it is traditionally affiliated. The officials in charge of these temples are responsible not only for the organization of the religious performances, but also for the conduct of village festivals and the administration of temple funds. In this sense, they are village-officials and their duties include many secular activities. While the position of senior temple priest or *umse* is always held by a lama, the offices of *chorumba* and *chorpen* are in village temples invariably held by laymen.

Both *chorumba* and *chorpen* hold their positions on behalf and with the consent of the village-communities who form the congregation of the temple; jointly they are responsible for the upkeep of the buildings and the deployment of temple income. They arrange for repairs, for which purpose they are entitled to use monies collected by public subscription or those accruing from fines.

Apart from the responsibilities which he shares with the *chorpen*, the *chorumba* has also the onerous task of maintaining discipline during the Dumje festival. At that time he is empowered not only to fine individuals who create disturbances but he may wield his long leather whip

to control a turbulent crowd. No one can complain if he is hit when the *chorumba* uses force in his efforts to restore order, and this privileged position of the *chorumba* demonstrates that Sherpa society will invest individuals with powers far greater than those enjoyed by even the most influential man without the authority of public office.

The temple officials, *umse*, *chorpen* and *chorumba* maintain a register of all householders to whom are assigned in strict rotation, irrespective of economic and social status, specific tasks relating to ritual and ceremony on public occasions. The executant of these civic duties is known as *lawa*, and *lawa* service entails the collection of public contributions, the arrangement of functions and the feeding, at the *lawa*'s expense, of the participants. On every religious occasion throughout the year *lawa* are appointed to supervise and carry out the work connected with public functions and over a period of years all householders in a village can expect to be called on to render several terms of *lawa* service. The most important *lawa* duties are those connected with the Dumje festival, for these include besides the normal services, the feeding of the entire village at the *lawa*'s expense as well as the provision of great quantities of beer and meals for the many lamas participating in the service. At minor rites, such as Yerchang and Tsirim and the annual reading of the Kangyur a *lawa*'s main contribution is in the form of the time and labour, for during the conduct of the rite he and his family must be in continuous attendance on the lamas.

The system of *lawa* service ensures the efficient execution of ceremonies and functions and extends the not inconsiderable financial and organizational burdens over all householders in a village; the allocation of *lawa* service by rotation implies the equitable distribution of civic duties.

A Sherpa village with its *naua* to guard its fields and its forests, its temple officials to arrange for the organization of worship and festivals, and its efficient system of public service by rotation would be virtually autonomous were it not that the State exercises the right to levy rent on the land cultivated. Unlike governments in other parts of the world, the administration of Nepal dispenses with a machinery of paid officials for the collection of land revenue and relies on the representatives of the villages to deliver clearly specified sums once a year to the treasury at the district headquarters. While in most hill regions of Nepal the revenue is collected by village headmen known as *mukiya*, *teluqdar* or *misar*, in Khumbu the position is more complex: the collecting agent is known as *pembu* and the revenue is not assessed on a village basis.

That this system has been in force ever since the government centred on the Nepal Valley established its right to collect revenue from the

Khumbu area is clear from documents still in the possession of the Khumbu *pembu*. In these no mention is made of villages, but only of certain *pembu*, as well as the number of houses and total amount of revenue for which each *pembu* was responsible. It is probable that the houses from which a *pembu* collected revenue were originally localized, but as at that time no survey had been made, there was no link between any piece of land under cultivation and the revenue paid by individual farmers, a *pembu* was free to apportion the revenue according to the means of his clients, *misir*; if a *misir* moved to another village he continued to pay revenue to his traditional *pembu*. It seems that at this time the *pembu-misir* relationship was more lasting and relevant than the association of a *pembu* with any specific area. The movements of families within Khumbu led ultimately to a situation whereby each *pembu* had *misir* in several villages, and the revenue of one village was collected by two, three or even four *pembu*.

There are at present seven *pembu*¹ responsible for the collection of land revenue in Khumbu and each collects the revenue of clients who are scattered over more than one village. Three of these *pembu* live in Namche, two in Khumjung, one in Kunde, and one, who until recently lived in Thamu, now resides in Solu, but continues to act as a *pembu* of Khumbu. The villages of Phortse and Pangboche and the whole of the Thami-chok area have no resident *pembu*, and this uneven distribution of the *pembu* would of itself make it clear that the *pembu*'s role is not that of a village headman.

Besides collecting revenue the *pembu* exercises control over the extension of the cultivated land in the main villages. Those wishing to take waste land under cultivation must first obtain permission from his own *pembu*, who may, but need not, increase his revenue. The transfer of cultivated land by sale or gift should also be executed through a *pembu*, but many pieces of land change hands without any *pembu* being consulted. It is necessary, however, for newly arrived Khambas to establish a link with one of the Khumbu *pembu* when settling in a main village, for without the permission of a *pembu* they can neither cultivate nor trade.

A Sherpa *pembu* is not just a collector of revenue, but stands to his *misir* in a relationship not unlike that of a senior kinsman. At the wedding of a man lacking father or paternal uncle, he may act in the place of the factor and may even bear part of the wedding expenses. Similarly if a man dies without heirs or kinsmen of his own lineage, his *pembu*

¹ While in 1957 the number of *pembu* was seven, the traditional number of *pembuships* is eight, and the reduction in numbers is due to the recent combination of two *pembuships* in one person. Originally there was also an officer known as *gembu*, but today no *gembu* exists in Khumbu.

inherits not only his property but also the obligation to perform the funeral rites.

In certain respects a *pembu* represents the community and its laws. Fines for breaches of certain customs are paid to the *pembu*, particularly in cases where there is no aggrieved party. Thus a man who marries his late wife's eldest sister, an act contrary to custom, must pay a nominal fine of Re. 1 to his *pembu*. The latter may also act as trustee in respect of compensation monies: a man who wants to marry a girl betrothed to another may deposit the customary compensation of Rs. 105, properly payable to the girl's fiancé, with his *pembu* as proof that he is prepared and able to pay damages; similarly a man whose father-in-law procrastinates over the performance of the final wedding rites, may make a *rit* payment of Rs. 6 to his *pembu* and carry off his betrothed. All such payments to a *pembu* are made in order to legalize a situation which has defied settlement by traditional methods.

Succession to a *pembuship* has always been determined partly by principles of heredity and partly by considerations of personal ability. An analysis of the succession of the eight *pembuships* of Khumbu during the last three or four generations shows clearly that the office has seldom remained in one family for more than two generations. Those sons or kinsmen of a *pembu* who were incapable of office have either refused to accept the position or if they accepted were soon replaced by men of greater drive and ability.

The influence that a *pembu* wields is entirely dependent on his personality. This is particularly noticeable when a *pembu* is invited to intervene in quarrels between villagers. Since he has no judicial powers, he can only mediate on the same terms as other villagers and his chances of success depend on his powers of persuasion and not on his status as *pembu*.

In view of the range of the *pembu's* responsibilities it is remarkable that even in a *pembu's* village of residence, the leadership of the village does not necessarily lie in his hands. In general the exercise of authority at the level of the village devolves on a small number of men of wealth and status, who do not compete for public office, but are nevertheless the power behind the village officers responsible for the day to day administration of village affairs.

8. MARRIAGE AND FAMILY LIFE

The Sherpa family consisting of husband, wife and their unmarried children, or in some cases of the two husbands and one wife, or one husband and two wives, constitutes a social and economic unit of great

independence. Inherent in the settlement pattern and the system of transhumance is the need for the individual family's self-reliance. Unlike a primary family among such sedentary populations as Chetris, Newars or Rais, the Sherpa family is not enmeshed in a web of close kinsfolk. From the moment of its establishment as a separate unit, a moment which usually coincides not with the inception of the husband-wife relationship, but with the husband's separation from the parental household, a married couple stands by itself, responsible to no one and relying on no one's support.

The emphasis laid on the self-sufficiency of the primary family stems partly from the nature of the marital relationship, which is a freely entered and terminable association between two equal partners, each of whom retains the right over the property he or she has contributed to the association. It is a characteristic of Sherpa society that the conclusion of the marriage rites and the setting up of an independent household is often delayed until the couple have had one or two children.

Except those young people who embark on a religious life and become monks or nuns, all Sherpas expect to marry and to found in due time a family of their own. Nevertheless there is no urge to precipitate marriage and many young people of both sexes defer even a firm betrothal until they are in their middle twenties without meeting with either the surprise or disapproval of parents and kinsfolk. Such a delay in binding themselves to a permanent partner does not imply a corresponding period of sexual continence. For the unmarried are free to enjoy casual sex-relations with any unmarried person not excluded from the range of potential mates by the rules of clan-exogamy or the prohibitions relating to intercourse between persons of *Khaden* and *khamenden* status. Pre-marital love-affairs, even if not a prelude to a permanent union, do not arouse adverse comment, for sexual intercourse between those neither bound by ties of marriage nor by vows of celibacy is not regarded as sinful nor as socially reprehensible.

This attitude of indifference to sexual behaviour when related to the unmarried, is shared by the parents of adolescent and full-grown daughters, who are free to receive the nocturnal visits of young admirers. Work in forest and fields and journeys to Tibet offer numerous occasions for contacts between young boys and girls, and at feasts and dances there is little restraint to courtship and a peculiar kind of rather rough horse-play. The jokes bandied between young people are very direct and listening to them one might conclude that Sherpa girls exercise little discrimination in the granting of sexual favours. Such a conclusion would, however, be erroneous. While in general no 'shame' is attached to sexual matters, and no girl resents a man's invitation to sexual congress, there

are only a few women who are considered promiscuous. The average Sherpa girl has probably had one or two lovers before she formally accepts a young man as her betrothed, and though a child born to a girl not yet engaged may be considered an inconvenience, hampering the mother's freedom to go on trading expeditions, no disgrace attaches to bearing a child outside marriage, nor does such a child materially affect a girl's chances of concluding a satisfactory alliance at some future date.

The freedom enjoyed by boys and girls to form attachments and become lovers results in many marriages which are entirely of the making of the young people; but some parents try to forestall the wishes of their children and arrange a betrothal while a boy and girl are still too young to express their wishes. In such cases there is necessarily so long an interval between betrothal and the celebration of the marriage rites that a young couple has plenty of opportunity to break off a relationship which one or both of them may find uncongenial.

The formal arrangements for the marriage of a boy and a girl extend over a period of years and at least three ceremonial visits must precede the conclusion of a marriage alliance with full rites. These are made on the initiative of the boy's kin, the first to make the proposal, the second to establish good relations between the two kin groups and the third to perform the rites of marriage. Auspicious acts, acts of friendship and fraternization, and acts denoting esteem and respect form, together with the giving and receiving of hospitality, an important part of the ceremonial. They represent a formal pattern of behaviour which is expressed in stereotyped idioms. *Sirkim* is a blessing, an invocation to gods, and is made at the time of drinking beer proffered at the beginning of an undertaking, a ceremony or a ritual; the performance of *sirkim* banishes evil and establishes auspicious surroundings. The presentation of *kata*, long muslin scarves, demonstrates esteem and respect, and in some cases expresses thanks to the recipient; *kata* are placed round the neck of the one to be honoured. *Yangdz'i* is the drinking together of two parties, one of whom offers and the other who receives beer in a cup given with both hands; the cup must be filled three times and when the third cup is half drunk, it must be returned to the giver who finishes the remains; the offering of *yangdz'i* signifies friendship, and after the settlement of quarrels it is used as a symbol of the re-establishment of normal relations.

The first formal step in the conclusion of a marriage alliance is a rite known as *sodene*; the father or senior male kinsman of the boy pays a ceremonial visit to the girl's house to make the proposal of marriage; they carry with them a wooden flask of beer to be offered to the parents. The girl's parents receive the party and after consulting their daughter

accept or refuse the beer, thus signifying their attitude to the match. Should the girl be undecided the parents will accept the beer and ask the visitors to return later for an answer, but if the beer is accepted then the boy's kinsman offers *yangdxi* to the father of the girl.

An accepted *sodene* gives the young man the right to visit his betrothed regularly in her parents' house, and if the young couple live in the same village, it is customary for them to spend every third or fourth night together.

The time that elapses between the acceptance of the *sodene* and the next rite of the marriage ceremonial, known as *dem-chang*, is normally a year, although in certain circumstances the period may extend over several years. Betrothal by *sodene* does not give either girl or boy exclusive sexual rights and a boy whose betrothed has relations with other men has no redress. He is free to break off the betrothal, but most young men look with equanimity on the infidelity of their betrothed and often the acts of unfaithfulness of engaged partners cancel each other out.

The relationship created by the acceptance of *sodene* is neither inherently permanent nor of legal effectiveness. It can be broken off at any time by either side without incurring liability to compensation, and while it lasts does not involve any economic obligations: the young man is not expected to help his prospective parents-in-law, nor will a girl normally work in her future husband's home.

The performance of a *dem-chang* necessitates lengthy preparations and involves the parents and kinsfolk of the girl as well as those of the boy in considerable expenditure, for the rites require the provision of food and drink for a large number of relatives. On the appointed day a procession made up of the relatives of the boy go to the house of the girl; they are dressed in their best clothes and carry with them a large barrel of beer, which is known as *dem-chang*. After the boy's party have been welcomed in the open and *sirkim* has been performed and beer offered, they proceed to the main room of the girl's house where they find her male relatives seated in strict order of precedence on the window bench. The boy's party sits down opposite the girl's kinsmen and then the *dem-chang* beer is brought in.

Then follows the most vital part of the whole ceremony; the presentation of white scarves (*kata*) by members of the groom's party to the parents and relatives of the bride. First, two young men drape one of the scarves round the centre post of the house; then they put a *kata* round the neck of the bride's father. After that, in sequence of seniority, *kata* are presented to the other relatives and clansmen of the bride, and while this is going on *yangdxi* is offered with cups of the ceremonial beer (*dem-chang*). It is on account of this drink that the whole ceremony

is known as *dem-chang*. After accepting *kata* and beer, the girl's father makes a speech; he welcomes the guests, declaring that on this day he gives his daughter to be the bride of so-and-so and that from now on she is the daughter-in-law of so-and-so's father. After this speech he is presented with another *kata* and the boy's father offers him *yangdxi* once more. The boy takes no part in the proceedings but he may join in the feasting and dancing which follow the formalities; the girl, however, must remain unobtrusively in the background and help the women of the household in the preparation of the food.

Tea, beer and food provided by the girl's parents are served to the guests and after the meal is over seats are removed and the men and women of the boy's party form a half circle and begin to sing and dance.

The dancing in the house of the girl's parents seldom lasts long for the near kinsmen of the girl are expected to offer similar hospitality to the boy's party in their own houses. Should the bride belong to a large, rich family, the feasting and dancing in the houses of her kinsmen may last several days; the ceremonial farewell from the girl's house takes place in the morning and is accompanied by the drinking of much beer and many offers of *yangdxi*.

The performance of the *dem-chang* has an important effect on the legal aspects of the relationship between the prospective spouses, but it makes for little change in their day to day behaviour. Both continue to live in their own houses and remain full members of their parental economic unit. If they have been accustomed to sleeping together they will continue to do so, but if the young man has not yet begun to visit his betrothed the *dem-chang* celebration will not necessarily mark the commencement of sexual relations.

While a child born to a couple betrothed by *sodene* is not considered legitimate and is known as *themba*, children born after the parents have been linked by *dem-chang* suffer no social handicap. It is for this reason that when a girl betrothed by *sodene* becomes pregnant every effort is made to hasten the date of the *dem-chang*; whereas should a girl be already pregnant at the time of *sodene*, the boy's kinsmen will include the presentation of *kata* in the *sodene* ceremonial, anticipating thereby the social and legal effects of the *dem-chang* and saving the child from being born *themba*.

There is, however, one important difference between the rights bestowed upon partners by the *dem-chang* and those resulting from the final wedding-rites. While the latter include the right of a husband or a wife to levy a fee known as *phijal* from any person committing adultery with their partner, no such right results from the *dem-chang*.

After the performance of the *dem-chang* several years may elapse before the parents of groom and bride agree to hold the final wedding-rites

and more often than not a couple's first children are born in the house of the girl's parents. The wedding-rites are only performed when a couple is able to set up a household of their own. Delay is often due to parental opposition: a girl's parents may not want to dispense with their daughter's labour or the boy may still play a vital role in the economy of his father's house.

To the Sherpa delay in the performance of the wedding-rites does not appear irksome or embarrassing, and it is only if boy and girl live in different villages that a bride's prolonged residence in her natal house is prejudicial to the development of normal relations between spouses.

The final wedding-rites, known as *zendi* or *gyen-kutop* either follow upon the *dem-chang* without further intervening ceremonies, or the groom's parents and kinsmen may pay two more ceremonial visits to the bride's parents. These are called *ti-chang*¹ and *pe-chang*.² Neither of them is obligatory, but wealthy people surround the *ti-chang* with nearly as great a show of hospitality as that offered during the *dem-chang*.

The culmination of negotiations and ceremonial visits, which have usually extended over several years, is the rite by which a man and a young woman, who may or may not have had sexual relations and often have already one or two children, are finally recognized as husband and wife. This rite terminates the girl's membership of her parental economic unit, and it is at the time of the wedding that she is given a share of the family property in the form of a dowry. This dowry remains her personal property for the rest of her life, irrespective of the success or failure of the marriage, and the wedding-rite has thus the subsidiary effect of establishing a woman as an independent legal person in possession of individual property. Though at the wedding there are several brief religious ceremonies, the emphasis of the whole procedure is not on the ritual, but on the economic aspects of the change in relationships. Much of the preparation is concerned with the collection of the dowry which consists not only of the property the parents give to their daughter, but also of the gifts of kinsmen, friends and co-villagers invited to the wedding. An exact list of these gifts is recorded in writing, for at marriages in the houses of the donors gifts of equal value must be returned; and in case of divorce this list is used to identify the property of husband and wife.

The ceremonies and feasting that precede the vital part of the wedding, the *gyen-kutop* ritual, literally 'the putting on of ornamental marks', resemble those that we have described at the time of *dem-chang*; a

¹ *Ti-chang* = 'question beer'; the 'question' relates to the date of the wedding.

² *Pe-chang* = 'meeting beer'; the 'meeting' relates to the discussion of the appropriate auspicious date for the wedding.

PLATE 28. Makalu, 8470 m., seen from the north-east. The precipice is about 3500 m. high. The strata dipping to the west (*right*) and the tectonic structures of the western limb of the Arun anticline are clearly visible





difference in emphasis is, however, provided by the presence of the groom and an officiating lama, and the speech which is made by the bride's father during the presentation of *kata*.

When the round of house-to-house visiting has been completed, the groom's party return to the house of the bride for the *gyen-kutop* rites. The lama makes offerings to the gods, recites sacred formulae and blesses the groom and bride who are seated before him. The groom's father anoints the bride's head with butter, while a kinsman of the bride does the same to the groom. The former declares that from this day the bride will be given the status of a daughter-in-law and he admonishes her to be faithful to the groom. Corresponding advice is given to the groom by the father of the bride. Then follows the dance called *silu chumbu*, which is only performed on the occasion of weddings.

While the dance is still in progress groom and bride, followed by several young unmarried girls who carry the dowry, and the groom's party leave the bride's house. Outside they are stopped by those of the bride's kinswomen who have entertained the groom's relatives at the time of *dem-chang* and *zendi*, and to them the groom must give gifts in cash in return for the hospitality his kinsfolk have received.

The bridal party go in procession to the house in which the newly married couple will reside. At the entrance beer is served and all receive handfuls of curd, butter, *tsampa*, sugar and *toma*, a kind of small root obtained in Tibet. If the bride has children she must herself carry them across the threshold.

The majority of first marriages are solemnized with rites that extend over several occasions, but there is also a simpler way of concluding a wedding. This short cut is known as *rit*—a term derived from the Nepali word *riti* (custom). It consists in the prospective husband paying a specific sum, usually Rs. 6, to the bride's parents and taking his bride to his house without ceremony or ritual. By making this payment the husband establishes the same rights as a man married by *gyen-kutop* and neither the couple nor their children suffer any legal disability. The only consideration which makes even poor people hesitate before they take this step, is the loss of prestige inevitably connected with an admission of inability to afford a wedding, and the greatly diminished prospects of any kind of dowry.

The device of *rit* is employed not only in cases of economic hardship, but also as the answer to an undue delay of the wedding ceremonies on the part of the bride's parents.

While marriages concluded by *rit* are in every respect equal to those celebrated with full rites, there is another type of union which though permitted by Sherpa custom has few of the legal consequences of a

PLATE 29. Lama dancers wearing yellow wool hats at the Mani festival at the Monastery of Thami

formal marriage. Such unions lack ritual sanction and are known as *tso-ni-dekino*, which means, literally, 'two people staying together'. They are formed by a man and a woman setting up house together and pooling their economic assets. People who have been married before conclude such unions, and though their children are strictly speaking *themba*, no social stigma results from this fact as long as both parents live together in one household. Among newly emigrated Khambas, who do not possess the necessary wealth to pay for the formal rites of *gyen-kutop*, such unions are customary, and even Sherpas of good status who have been married several times may not trouble to perform elaborate wedding ceremonials. They live together in such unions without incurring community disapproval.

While monogamy is the most usual form of marriage, the Sherpas also practise polygamy and polyandry. Their basic attitudes to the husband-wife relationship finds a particularly plastic expression in these two types of multiple marriages. Of these polyandry is the more frequent. Among 236 marriages which I recorded in Khumjung, Kunde and Phortse, there were nineteen polyandrous and only five polygynous unions. This is in accordance with the Sherpa belief that polyandrous marriages are a time-honoured and respectable device which prevents the fragmentation of property and fosters the solidarity of brothers; a man's marriage with more than one wife at a time is considered more in the nature of an emergency measure, if the first wife has remained childless, but neither spouse desires a divorce.

In the case of polyandrous marriage rites *dem-chang* and *gyen-kutop* must be performed in the name of both brothers; and at the *gyen-kutop* rite the bride must sit between both grooms so that all three may be anointed with butter at the same time. If there are three brothers in a family it is not uncommon for the eldest and youngest to marry one wife with the idea of jointly taking over the family property, while the middle brother enters a monastery as a novice. Many girls prefer to marry two brothers. Such a marriage improves a woman's economic prospects, and assures her in later years of the enjoyment of a comparatively young husband. I have heard of more than one girl who refused to marry her betrothed, even after the birth of a child, unless the younger brother was included in the marriage ceremonial, and this even when the young brother was eight or ten years her junior. Indeed age plays no role in the conclusion of such multiple marriages and many of the polyandrous marriages in Khumbu have resulted from the initiative of the parents of brothers at a time when the youngest brother was too young to express an opinion in the matter.

While the desire to preserve the inheritance of two brothers in a single

economic unit is no doubt foremost in the minds of parents arranging polyandrous matches, it would be erroneous to assume that polyandry is the outcome of economic stringency and that only brothers 'who cannot afford separate wives', resort to this form of marriage. Far from being more frequent among the poorer strata of society, polyandry is only practised among the richer families. It evokes social approval as a symbol of fraternal solidarity and I have heard older people complain of the 'selfishness' of present-day young men, who will break up an estate, because each wants a wife to himself. If there is today a movement away from polyandrous marriages—and in the absence of data on past generations it is difficult to trace any such tendency—it must be attributed to the influence of young men returning to Khumbu after prolonged visits to Darjeeling and other places where polyandry is frowned on.

Jealousy between joint husbands is rarely responsible for the dissolution of a polyandrous union. A more frequent reason for separation is disagreement over economic matters and this is generally based on the sentiment that one brother does not exert himself sufficiently in the interests of the joint household, or that he uses cash earnings—such as earnings as an expedition porter—to satisfy personal needs rather than contribute them to the common pool. In the event of a separation, which always involves the division of property, the joint wife usually remains with the older brother, while the younger seeks a new wife.

Polyandry in Khumbu is of the fraternal type, and a polyandrous union must be constituted as such at the time of *dem-chang* and wedding. Younger brothers who have not been included in the ceremonies of *dem-chang* and *gyen-kutop* cannot later claim the rights of a husband, and Sherpas laugh at Tibetans who permit a man and his son by a former marriage, or a man and his father's brothers, to share one wife.

Polygynous marriages are less frequent than polyandrous unions, and I know of no instance of a man marrying two wives at the same wedding ceremony. Yet, a wife's younger sister, who is unmarried, divorced or widowed, may join her brother-in-law's household as a junior wife, and if her parents are alive *dem-chang* and *gyen-kutop* are often performed.

The wives in a polygynous household need not necessarily be sisters, but in about half the cases of polygynous marriages I recorded they were either sisters or parallel cousins. While Sherpa custom does not permit marriages of more than two husbands with one wife, no limit is set to the number of wives a man may have at one time. Nevertheless, there was in 1957 only one man in Khumbu who had three wives: the first wife lived in a village of Pharak, while the other two, who were sisters but of different clan from the first, lived in Namche Bazar and the husband, an affluent trader, divided his time between the two households.

The relations between joint husbands and the children born to their common wife do not lead to emotional conflict. The question of biological fatherhood is not one of importance; both husbands treat all children as their own, and the children call both men father. Since as long as a polyandrous marriage lasts, both husbands, being brothers, hold their property jointly, all children are entitled to equal shares in the common property.

Sherpa marriages are free associations between individuals who have the right to dissolve them when they fail to serve the purpose of providing mutual comfort and happiness to the partners. There is no need to argue a case for the termination of the marriage tie before a judicial body nor to convince co-villagers or kinsmen of the desirability of divorce. Many marriages are dissolved by mutual consent, and if both partners agree to separate, a simple ceremony, known as *nia-tongu*, is performed: the husband invites the wife's parents, brothers or other close kinsmen to his house, entertains them with liquor and beer, and declares that he and his wife will separate and that from now on he is no longer their son or brother-in-law; a thread, held by the husband and one of his wife's kinsmen, is broken as a symbol of the severing of the relationships established by the marriage; the wife gives her husband one rupee as token repayment of the beer brought by his kinsmen at the time of *sodene*.

If either husband or wife is reluctant to divorce, the other partner can yet insist on the dissolution of the marriage. There is no need to prove the guilt of the other spouse, but compensation in the shape of Rs. 35 is paid by the partner wishing to terminate the marriage. This payment, known as *phorjal*, releases husband or wife from all obligations arising from the marriage bond.

Both husbands and wives show a remarkable tolerance towards their spouses' sexual digressions. Temporary lapses are seldom considered sufficient reason for the break-up of a marriage, and even the lover in an illicit adventure is only fined. Though a husband has the right to claim *phijal*—a fine of Rs. 30 from his wife's lover—there are many cases of husbands not exercising this right, but accepting instead an apology, a bottle of beer and the offer of *yangdxi*. Particularly if the offender is a monk, an aggrieved husband may be reluctant to impose on him the indignity of paying *phijal*, and content himself with the offering of beer and *yangdxi*.

With the payment of a fine or the acceptance of a bottle of beer and *yangdxi*, whereby a man's guilt is publicly admitted, the incident is forgiven and forgotten, and normal relations between the parties are resumed.

The ease with which cases of adultery are settled must not lead us to

believe that the Sherpas' attitude to extra-marital sex relations is either amoral or one of indifference. As devout Buddhists they regard sexual intercourse with another man's wife as sinful, and consider such a relationship between a married man and an unmarried girl as sin (*dibka*). The payment of *phijal* and the offering of *yangdxi* can to some extent remove sin, but there is in the Sherpas' minds no doubt that an act of adultery diminishes the *sönam* (merit) of those involved, and that many deeds of merit are required to expiate the sin and make up for the loss of *sönam*. Sexual intercourse is morally neutral only between unmarried persons; for them it is not sin, unless either of the partners has taken vows of celibacy.

Death does not end the obligations and rights created by *dem-chang* and *gyen-kutop*; a married man's rights pass to his younger brother, or failing a younger brother, to those of his father's brother's sons who were his juniors in age, and thus stand to the widow in the relationship of husband's younger brother. If any of these is still unmarried at the time of the husband's death and is willing to accept the widow as his wife, and if she agrees, it is not necessary to repeat the rites of *dem-chang* and *gyen-kutop*; the widow goes to live in the house of her husband's junior kinsman without further ceremony.

If no such kinsman is available, or the widow wishes to free herself of all obligations towards her late husband's family, she presents a sum of one rupee, known as *chang-ring lbo-wu*.¹ to her late husband's kin, and declares herself willing to perform the rite of dissociation, known as *ankan pankan*.² This rite, which can only be performed with the consent of both parties, entails the exchange, breaking and throwing away of two pieces of wood, after which the widow shakes and brushes her apron, and declares that she is now free of the control of her late husband's family.

9. PROPERTY RIGHTS AND INHERITANCE

The Sherpas place great emphasis on the sanctity of individual property, and even children have the right to retain for themselves money or goods which they earn or receive as gifts. Young boys and girls are encouraged to engage in petty trade on their own account, and by the time a girl sets up her own household she is often an experienced trader with some capital of her own. Many married women, and particularly those whose husbands are often away from home, do a good deal of moneylending

¹ *Chang*=beer; *ring*=price; *lbo-wu*=return; i.e. the return payment of the beer given by the husband at *sodene*.

² A Nepali term, the literal meaning of which is unknown to the Sherpas.

trading on their own account. A dowry remains a woman's private property, just as a man's share of his father's property, which he received when he established his own household, belongs to him personally. As long as a marriage endures both spouses share equally in the enjoyment of their common property, but if the marriage breaks up each spouse lays claim to that which he or she brought with them at the time of the wedding; whatever they have earned during their married life is divided into equal parts. The Sherpas justify this by the assumption that an increase in the possessions of a married couple is due to the efforts of both husband and wife, each of whom is consequently entitled to an equal share.

The rules of inheritance are based on the principle that all sons, irrespective of age, have equal claims to the joint property of their parents, and all daughters are entitled to dowries of like value. After setting aside sufficient to cover the dowries of his daughters, a father will divide his property into a number of shares corresponding to the number of his sons plus one share for himself. As his sons marry they receive their shares, while the father's share is used to maintain himself during his lifetime. After the father's death his share will be distributed equally between his sons, provided that they contribute equally to the costs of his cremation and mortuary rites. If, however, a younger son, who has continued to live in the father's house, pays the total expense of the funeral ceremonies then he is entitled to inherit the whole of the father's share. The house of a Sherpa family falls generally to the portion of the youngest son. For it is he who after marriage remains in the parents' house and manages both his own and his father's property. In this way, the youngest son obtains often a share slightly larger than that of his elder brothers.

The property of childless couples normally passes to the sons or brothers, or failing these to close agnatic kinsmen. But if there are only daughters, the youngest will be married to a resident son-in-law and this son-in-law is recognized as the formal heir. Since this device deprives the agnatic kinsmen of all prospects of inheritance, it is customary to consult them before arranging such a marriage and to pay them a small sum as nominal compensation at the time of the wedding. A resident son-in-law is known as *maksu*, and no loss of prestige attaches to the acceptance of such a position. The *maksu* undertakes the obligation to care for his parents-in-law in their old age, and to arrange for their funeral. In return he takes over their entire property and enjoys the usufruct as long as he lives with his wife in her parental house. Should she leave him to marry another man, he remains nevertheless in possession of the house and all the other immovable property, but if he takes the initiative in a divorce he forgoes the rights acquired through his marriage.

10. PRIESTHOOD AND MONASTERIES

Buddhist thought and practice permeates the Sherpa way of life; the patterns of behaviour and the moral precepts characteristic of Tibetan lamaistic civilization govern the conduct of both worldly and spiritual affairs and everywhere in Khumbu are to be seen the tangible manifestations of the Buddhist faith. Along the paths sacred texts are carved into rock faces and boulders; stone walls and monuments, in the shape of stupas, bear stone slabs with engravings of the sacred formula, *om mani padme hum*; brooks are lined with water-driven prayer-mills; high, white prayer-flags rise above many roof tops; nearly every village has its own temple containing libraries of sacred books, notably the 108 volumes of the Tibetan Canon and the 225 volumes of the Canonical Commentaries, statues representing figures of the Buddhist pantheon and painted banners and frescoes.

The people of Khumbu adhere to the Ningmapa sect, one of the oldest sects of Mahayana Buddhism. In Tibet there are many Ningmapa monasteries and nunneries, but in Khumbu the building of temples and monasteries is of comparatively recent development. According to local tradition, the present village temple of Pangpoche is considered the first and the oldest in Khumbu, and its foundation is ascribed to the legendary figure of Lama Sanga Dorje, the sixth reincarnation of Changma Dorje, whose twelfth reincarnation is the present abbot of the Tibetan monastery of Rongphu, which lies on the northern slopes of Mount Everest. Lama Sanga Dorje, who is believed to have introduced lamaistic temple ritual into Khumbu, is today worshipped as the patron saint of Khumbu, and the Sherpas point to many landmarks as the products of his miraculous feats: they believe that the groves of old juniper trees on both sides of Pangpoche temple sprang from the hair the saint cut from his own head, and scattered to left and to right of the site chosen for the temple; and they point to a roof-like projection of rock which the saint is supposed to have pulled out of the mountainside to obtain shelter when he first arrived at Pangpoche.

Lama Sanga Dorje's death, like his life, was accompanied by miraculous events. His body was not cremated but evaporated in the form of a rainbow, and only the eyes, tongue and heart remained. These were enshrined in a silver casket and are now the cherished possession of the Pangpoche temple. This temple was for a long time the centre of religious life in Khumbu and it seems that during the two or three centuries which followed the death of Lama Sanga Dorje the development of Buddhist institutions was slow. Gradually other villages followed the example of Pangpoche and built temples, in which the whole

community assembled for the celebration of the seasonal feasts and individual lamas performed rites commissioned by pious villagers; the establishment of monasteries inhabited by celibate monks is, however, a phenomenon of the last fifty years.

While the monasteries are today the main focal points of Sherpa religious life, the performance of seasonal and domestic ritual is mainly the responsibility of the lamas resident in villages. The position of such a village lama must not be confused with that of a parson or priest appointed by a superior religious authority, and is also unlike that of a priest with hereditary ties to locality goods such as is found in many Indian tribal societies. A village lama is simply a person who has received religious instruction enabling him to perform certain rites and is resident in the village. He may have been taught by another village lama, or he may have spent some years as a novice or a monk (*thawa*) in a monastery before returning to secular life. A village lama need not have taken any vows nor does he require to be elected or appointed. He is in no sense a village dignitary.

Most village lamas are married, own land and cattle, and depend only partly on the fees they receive for their ritual services. But marriage and the cares of property-owning does not prevent a village lama from striving after further spiritual perfection, and the honour and prestige which goes with virtue and wisdom. The recognized manner of enhancing knowledge and spiritual power is the practice of *tsam*, which involves isolation in a hermitage, or more rarely seclusion in one's own house. The duration of a *tsam* is not prescribed, but the most effective is an isolation for three years, three months and three days. During such a period a lama may be visited only by a disciple, servant or a kinsman who brings him supplies of food and ritual accessories, and by superior monks or lamas, who can guide him in his spiritual exercises. An important part of *tsam* is fasting when no nourishment may be taken except a small quantity of milk mixed with water and certain herbs three times a day. While in isolation a lama spends his days in the study and recitation of sacred scriptures and in meditation.

A village lama must be literate and he must have some knowledge of the scriptures, all of which are written in classical Tibetan. But education in religious matters is not confined to clerics and a good many laymen are able to co-operate actively in ritual, and most wealthy people possess small collections of books, and know how to recite sacred texts with the proper intonation.

The influence of Tibetan Buddhism is expressed in the Sherpas' artistic sensibility. These people who must make great efforts to extract a living from an inhospitable environment spend a great deal of time and

money on artistic representation. Many a wealthy Sherpa's house contains a room arranged like a temple, whose walls and ceiling are decorated with religious paintings. Most of these frescoes are of considerable aesthetic merit and the decoration of a private place of worship can easily cost the equivalent of £300.

The village, with its inhabitants engrossed in the pursuit of husbandry and trade, represents only one side of Sherpa life. The other side is represented by monasteries and nunneries, by the lonely cave-dwellings of hermits and the small settlements of lamas within easy reach of the habitations of lay village-folk. Sherpa society embraces the laity as well as the many men and women who choose the religious life, and the one part is incomplete and incomprehensible without the other. Unlike the Brahman priest of Hindu society, whose place is invariably inside secular society, the Buddhist lama has the choice of either living in the midst of the laity, a villager among villagers, or of abandoning all secular ambitions and associations and devoting himself exclusively to spiritual pursuits. While personally withdrawing from lay society, he does not withdraw his services; indeed the monastery and its monks are forces of vital importance for Sherpa society and Sherpa culture.

There is no cleavage between the Buddhist doctrine practised in the monasteries and the Buddhism as the folk-religion of the ordinary village. Both have their roots in the Tibetan religious tradition, and the worship of local deities foremost in the religious thought of the untutored layman is not excluded from the ritual performances in monasteries. The intellectual levels of the religious practices of monks and laymen are undoubtedly very different; and that which thinkers versed in the philosophy of Tantric Buddhism recognize as symbolic of immaterial processes of thought appear in the practice and belief of the majority of monks and laymen as substantial reality, represented in the shape of demons and deities, whose traditional shapes constitute the principal motives of the temple frescoes. But this substantialization of religious ideas distorts neither for the monks nor for the laity the fundamental Buddhist idea of the transitoriness of the material world and the existence of eternal principles beyond the multiplicity of material phenomena.

Fifty years ago there existed in Khumbu no institution which might have been called a monastery or nunnery. There were three ancient temples, at Pangpoche, Thami and Kerok and the more recently founded temple of Khumjung and Namche. Attached to each of these temples were several lamas, and in the case of the Thami and Kerok temples, one particular family of lamas had been in charge of the temple for several generations. But all these lamas were married men, and there were,

as it seems, no monks (*thawa*) who had taken vows of permanent celibacy. Besides these married lamas there were hermits who for a number of years occupied cave-dwellings or solitary huts high above the inhabited valleys, but none of them seem to have attempted to turn their personal retreat into a settlement where others might join them in their life of meditation.

Today there are several monasteries in Khumbu, the most important being Tengpoche¹ which was founded less than forty years ago by Gulu Lama, the son of wealthy parents of Khumjung. Though as a child Gulu Lama showed more interest in the study of the scriptures than in the work on fields and pastures, he complied with his parents wishes and married. He had several children but when his wife died he devoted himself to the active practice of religion, and went to study in Tibet. Subsequently he returned to Khumbu and retired to a hermitage on a hill-slope above Khumjung. As his reputation as a lama grew, a small group of similarly inclined men and women gathered round him. Encouraged by the abbot of the Tibetan monastery of Rongphu he decided, after some years, to found a monastery. He chose a site for the building, the present Tengpoche, on a broad spur that rose high above the Dudh Kosi gorge and commanded magnificent views over a number of snow peaks. The Sherpas of the surrounding villages provided the labour and the funds with which to build a large temple, but the construction of the dwelling houses was left to the initiative of the first monks.

One of the principles determining the composition of a community of monks is the general rule that every member must provide for his own lodgings and to a great extent for his own maintenance. Unlike the members of religious institutions in some other societies, including certain religious orders in Tibet, a monk in a Sherpa monastery is responsible for his own household, or if he chooses to share a house with other monks, for a share of the expenses. Monastery funds are utilized for feeding the monks only at certain ceremonial meals to be eaten in the course of festivals and for the provision of tea served during the daily temple services.

It is for this reason that only the sons of good status families can enter a monastery as a novice. The parents of a novice must either buy or build him a house, or—more frequently—arrange for him to live with an older kinsman or friend of the family who is already established as a monk. At the beginning the parents provide the young novice with food and other necessities, but when it seems probable that he will persist in a monastic career, they give him a share of the family property,

¹ Or Thyangboche. See note on Tibetan place-names, p. ix.

similar to that given to a son at the time of marriage and separation from the parental household. Land and houses belonging to monks are frequently rented out but it is more usual for monks to sell such immovable property as he receives from his parents and invest it so that it will yield a steady income of agricultural produce. The high rates of interest paid by Sherpas—twenty-five per cent per annum being the usual rate—enable a single man to live on the income from even a modest capital, and as there is always a demand for cash loans, no monk has difficulty in finding borrowers who will undertake to supply him with agricultural produce in payment of interest.

Most monks also derive a small income from fees received for the performance of rites in private houses or at village festivals and from donations of wealthy visitors to the monastery. It is usual for such visitors to make contributions to the monastery funds, and to distribute also a certain sum among the monks in residence, or alternatively pay for a meal of which all the monks partake.

The first monks who joined the founder at Tengpoche were his brother's son and three other men of his home village of Khumjung; within ten years the number of monks in Tengpoche increased to twenty-five and the monastery rapidly became the centre of religious activities within a wide area. But ten years after the foundation a catastrophe occurred which might well have daunted the spirits of a people less resolute and devout than the Sherpas of Khumbu. In the great earthquake of 1933 the main temple collapsed, and Gulu Lama, then eighty-five years old, died shortly afterwards of shock. He was cremated in the ruins of the monastery, on the site where the great hall of the temple had stood.

Once more the villagers of Khumbu came to the help of the young monastery. Giving money and free labour they rebuilt the temple, making it even bigger than it had been before. The best painters were employed to paint the frescoes adorning its great halls and the porch before the entrance. There the four *gyeldzen deshi* (guardians of the four quarters) flank the door, and a *mandala* covers part of the ceiling. The main hall is painted in red and is hung with a number of precious *tankha* or painted scrolls. The hall on the first floor contains a statue of Gulu Lama, fashioned rather crudely by a local painter.

Gulu Lama's personal belongings were preserved intact, for it was generally believed that he would be reincarnated and resume his place at the head of the monastery. This assumption proved correct; three years after his death it was reported that a small boy, the son of Tibetan immigrants living in Namche Bazar, was continually speaking of his home in Tengpoche, where he had a house and many possessions. Monks of

Tengpoche, sent to observe the boy, were satisfied that he might prove to be the reincarnation of their dead abbot and recommended that he should be subjected to the usual tests that precede official recognition of reincarnate lamas. The possessions of Gulu Lama were mixed with similar articles belonging to other lamas, and the boy was asked to choose those which had belonged to the late abbot. This he did without hesitation, and so established his identity as the reincarnation of the dead Gulu Lama. The monks brought the boy to Tengpoche, and one of the monastery officials, who was Lama Gulu's brother's son, took the boy into his own house and devoted himself to the young lama's education. As the first reincarnate abbot of Tengpoche, the boy was regarded with veneration from the day of the official recognition. At the age of fifteen he was taken to the Tibetan monastery of Rongphu for further studies and when in 1956 he returned to Tengpoche he was ready to assume—or in the Sherpas' view—to reassume his place as the head of the monastery. Old and young monks accepted his authority unquestioningly, and paid him the respect which he had received in his last incarnation. The dignity of this young man in his early twenties is impressive, and Sherpas from near and far visit him in his study, which is decorated with frescoes and lacquer work and filled with Tibetan books; men and women prostrate themselves three times before they kneel to receive his blessing and none approaches without an offering of cash or food; visitors of standing are entertained with butter tea.

Today Tengpoche has not only a young man as its abbot, but the average age of the monks is not more than thirty-five. Since the foundation in 1923 many boys and young men of the villages of Khumbu have come to the monastery to learn and to be initiated into the religious life. Not all have proved temperamentally suited to the contemplative life of monks. Some left the monastery to take up secular occupations, some married and settled down as village lamas, but others remained true to their monastic vows, content to make Tengpoche their permanent home.

The proportion of those who remain permanently devoted to the religious life is approximately fifty per cent. The total number of monks admitted to Tengpoche during the thirty-four years of the period from 1923 to 1957 was ninety-one. Of these eight died in the monastery, one founded a monastery of his own, thirty-eight were in residence in 1957 and forty-four monks had either voluntarily left Tengpoche to return to secular life, or were compelled to leave on account of associations with women, which had come to the notice of monastery officials.

Kinship connections with a senior monk greatly facilitates a boy's entrance to a monastery and reduces the financial burden of the parents. For in such a case a boy can live with a relative for several years, and

he may ultimately inherit the house in which he has resided. Considering that the majority of the monks of Tengpoche came from the wealthier and more prominent families of the three villages of Namche, Khumjung and Kunde, it is obvious that the web of consanguinous and affinal ties connecting most of these families extends also to the monk-community of Tengpoche.

The same social stratum which furnished most of the monks of Tengpoche, provided also the inmates of Devuche a small nunnery situated less than half an hour's walk from the monastery. Like the monks, the nuns of Devuche live in individually owned houses, standing in small groups among the pines and rhododendrons of a sheltered valley. In the middle of the settlement there is a medium-sized temple, containing some of the most beautiful frescoes of Khumbu. In 1957 there were twenty nuns in residence, but only nine of these had the qualifications necessary to take an active part in the services of the temple—services which are the counterpart of those conducted in male institutions. The remaining eleven were either devout women without learning, or nuns disqualified by a breach of their vows of celibacy. Fourteen of the nuns had never been married—though two had illegitimate children—and six had been married, but had come to Devuche after being widowed or separated from their husbands.

The percentage of nuns who remain for the whole of their lives in Devuche is no greater than that of monks who resist the temptations that a worldly life has to offer. Since the foundation of Devuche twenty-seven years ago fourteen nuns have left the nunnery and married, and in ten of these cases the husbands were ex-monks of Tengpoche. Indeed the proximity of monastery and nunnery would seem to have offered undue temptations to men and women under vows of celibacy.

Tengpoche and Devuche are not the only monastic establishments in Khumbu. At Thami, the largest village in the valley of the Bhote Kosi, a family of married or *gyupi* lamas has for many generations been in charge of a temple tracing its origin to Lama Sanga Dorje. This temple was a small building, and the only lamas living in the neighbouring houses were members of the present head lama's lineage. Even when his predecessor, known as Lama Tundu, succeeded his father there were no celibate monks at Thami, and several lay-families dwelt in the settlement clustering round the temple. But in the year 1920 Lama Tundu decided to shift the temple to a place where a larger structure could be erected, and the abbot of Rongphu, the same man who had supported Lama Gulu in the founding of Tengpoche, encouraged him in this undertaking. The completion of the three-storied building in its present shape prepared the way for the development of the Thami

temple from a family institution to a monastic establishment catering for a wider circle of students and lamas.

Young men desirous of becoming monks soon collected. Most of them came from the villages of Thamichok, and small houses, built into the rocks of the steep mountain slope, began to spring up round the new temple. Among the first novices were several sister's sons of Lama Tundu, but others had no ties of kinship with the lama's family. By 1957 Thami temple, the official name of which is Gon-de Dziri-chu-ko, had grown into a monastery comprising married lamas as well as celibate monks or *thawa*, with a full complement of monastery officials and the facilities for staging performances of even the great Manirimdu dance festival.

The inspiration for this development—like the inspiration for the foundation of Tengpoche—came clearly from Rongphu, the famous monastery of the Nyingmapa sect on the Tibetan side of the Mount Everest group, and no year passes without some of the Thami monks visiting Rongphu for study and religious practices. It was in Rongphu that these *thawa* first took their vows and later received instruction in the ritual dances of the Manirimdu.

The first half of the twentieth century saw the emergence of monastic institutions not only in Khumbu, but also in various parts of Solu. Monasteries and nunneries have sprung up at Chiwang, Trakshindo, Tolaka, Gole and more recently at Todhung. While in many parts of northern Nepal, such as the valley of the upper Arun River, Buddhist institutions are in a state of decay, in Khumbu and Solu there has been a sudden flowering of Buddhist culture, stimulated no doubt by influences from the other side of the great Himalayan range.

II. MORAL CONCEPTS AND RELIGIOUS BELIEFS

The Sherpas' religious beliefs and practices are those of Tibetan Buddhism, and although there are great differences in the sophistication between the more learned monks and lamas on the one hand and the ordinary villagers on the other, the basic religious and ideological concepts are common to all members of Sherpa society. Both the laity and clerics think of the desired end-state towards the attainment of which all moral actions are directed, in the terms of Buddhist philosophy, and the difference between the two classes lies more in the means employed to attain it, than in their concept of the nature of the ultimate human goal.

An analysis of Sherpa moral concepts begins most conveniently with the examination of the idea of *sönam*, 'religious merit', which corresponds roughly to the concept of *dharma* as prevalent among the Buddhist

populations of the Nepal Valley. Sherpas believe that every act of virtue (*gewa*) adds to an individual's store of *sönam*, whereas every morally negative action or 'sin' (*digba*) decreases this store. Addition and subtraction of *sönam* is thought of in more or less mechanical terms. Throughout a man's or woman's life, good and bad deeds make their marks on a person's record sheet, and this process is imagined as the action of two anthropomorphic beings, believed to be born with every individual and sitting invisibly on his right and left shoulder. The former, known as *lhen-cig-kye-wai-lha* is the person's good genius who marks every deed of virtue with a white mark, while the latter, known as *lhen-dig-kye-wai-dre* is his evil genius, who strives to lead a man along a downward path and marks every sin with a black sign.

At a man's death the account is made and the balance of white or black marks determines his fate in the next world. It is therefore everybody's endeavour to accumulate as much *sönam* as possible, and to avoid as much as possible actions likely to diminish the stored up merit. Moral prescriptions may thus be seen as a guide to the acquisition of *sönam*, and the acts they enjoin are teleological in character. But while they are as purpose-directed as the prescriptions of conduct in the ideologies of many less sophisticated tribal societies, the desired end-state of Sherpa ideology is not this-worldly, but clearly transcendental. There is no promise of well-being and prosperity in this life as the result of *sönam*-gaining actions, but the promise of bliss or release in the world beyond.

Though authoritarian elements are not lacking in Sherpa thought, and monks and lamas undergoing religious training accept the authority of their spiritual preceptor in problems of faith and morality, the system of rewards and retribution implied in the *sönam* concept is not anchored to any specific supernatural authority imagined in anthropomorphic terms. The unpleasant consequences of sin in the life after death are virtually automatic and not imposed by a supernatural authority, nor is it believed that 'sin' offends any specific deity. Yet spirits or departed kinsmen may be offended by human actions and this shows that the idea of supernatural sanctions operated by personal beings is not foreign to Sherpa mentality. But the actions offensive to such beings are not necessarily morally negative, and may be of a trivial nature. Neither spirits nor the deceased seem to be concerned with the enforcement of the moral code.

Closely linked with the idea of rewards and retributions in the world beyond is the concept of reincarnation. This concept, basic to much of Hindu religious thought, is not peculiar to the Sherpas or even to Tibetans in general, but unlike Hindus the Buddhist Sherpas and Tibetans give social recognition to the belief in the reincarnation of individual

persons and reincarnate lamas play a vital role in the religious system. Persons who have gained so much *sönam* that they would be entitled to the final release, or in Sherpa words to entry into Devachen, a kind of super-paradise beyond the world of the six spheres, may return as reincarnate lamas to the position they held in their former life, and as they are believed to retain the knowledge gained in previous lives, they are attributed with a degree of sanctity far exceeding that of even the most devout person in his first life.

Morally positive acts, which add to a person's *sönam* include conduct ranging from the building of religious monuments to small acts of kindness to animals. Indeed the range of merit-producing behaviour is so great, that no concise definition of virtuous acts is possible. Unlike monotheistic religions, such as Christianity, the Sherpas' Buddhist ideology does not provide a motive for moral acts comparable to such ideas as the 'love of God' or 'obedience to the commands of God'. Though the one supreme motive for leading a good life is in Sherpa eyes the wish to acquire *sönam*, this motive is not directly linked with a belief in a personal deity to whom man is responsible for his behaviour. Similarly 'sin' is in the Sherpa's mind not an act which offends any particular deity, but an offence against a moral order existing independently of any of the gods the Sherpas worship.

The nature of behaviour believed to produce *sönam* can be understood, however, from a list of acts described as meritorious by my Sherpa informants. Sherpas are usually not very systematic in enumerating such acts, but here I have grouped them into three main categories: religious and ritual acts, acts in relation to persons, and acts in relation to animals.

All prayer and the recitation of sacred scriptures fall into the first category. It is meritorious to read and recite any of the sacred books, as well as to pay others to recite them. Thus the 108 volumes of the Kangyur, kept in a village temple, are annually recited by lamas paid from a fund which the villagers raise by public subscription. All those subscribing derive merit from this reading of the scriptures, and there are many occasions when individuals or groups may commission recitations of this type. Different from the mere reciting of scriptures, is the performance of rites which, in addition to the recitation of the appropriate liturgical texts, involve the presentation of food offerings and butter lamps, and the playing of musical instruments. Such rites too may be commissioned by individuals, who either derive *sönam* personally from the performance, or can direct the *sönam* thus produced to the assistance of a deceased relative.

The turning of prayer-wheels, circumambulation of temples and religious monuments, and above all the construction of such monuments

PLATE 30. The north-east face of Chomo Lonzo, 7815 m. The two glaciers which unite to form the Sakyetang Glacier at about 4200 m. have no névé catchment area. They are fed entirely by avalanches. The complicated tectonic folding is clearly visible, e.g. that facing north in the direction of the anticline of the north *arête* (right)





are all productive of *sönam*. The Sherpa country is full of *mani*-walls, bearing stone tablets with engravings of the sacred formula, *om mani padme hum*, and of rock inscriptions containing this and other sacred formulae. The *sönam* produced by their construction or carving goes to the person who paid for the work, and not to the workmen or the artisan.

The second category of meritorious acts includes all those involving interpersonal relations. All kinds of charity produce *sönam*. Gifts to lamas, whether they are in need of them or not, as well as alms to the poor result in the gain of *sönam* by the giver. It is particularly meritorious to feed those lacking food, and to clothe those inadequately dressed. Acts which indirectly benefit others, such as the building of bridges or rest-houses, fall also within this category. On the occasion of religious festivals wealthy people distribute food and drink in the expectation of gaining *sönam*.

It is considered meritorious to act as peace-maker. Many quarrels are settled by persons without official status who, far from deriving any profit from their activities in the interest of social harmony, incur considerable expense in providing the drink necessary to bring the parties together. What they gain is *sönam* and social approval. It is significant that Sherpas admire a skilful mediator and man of peace more than a 'strong' man. Their ideal is not the heroic personality, but the man who is wise, restrained and mild.

This emphasis on the virtue of mildness is particularly apparent in the Sherpas' attitude to animals. Acts of kindness to animals are a source of *sönam*, and I was told specifically that a person about to hit a dog or a cat, which has stolen meat or butter, may pause and let the animal get away with its ill-gotten gains for the sake of acquiring *sönam*.

These examples of *sönam*-producing actions reflect the type of conduct considered ideal for laymen. The members of monastic communities have additional means of acquiring *sönam*, not the least important of which is the voluntary renunciation of sex and family life. For them sexual congress is sinful, quite irrespective of the status of the other partner, and their action is hence not judged on the basis of rules regulating interpersonal relations. The monk who consorts with an unmarried woman sins only because he breaks his vow of celibacy, and his partner sins because she causes him to sin. Were he not bound by his vow, sexual relations between the two persons concerned would be considered morally neutral.

The vast majority of 'sins', however, relate to interpersonal behaviour, and result in particular from any infringement of the rights or dignity of another person. The way in which Sherpas view such infringements

PLATE 31. The great hanging bridge on the trade route which crosses the Arun River near Num

is demonstrated by the following list of sins enumerated spontaneously by one of my lay informants: to quarrel, steal, cheat in trade; talk ill of another behind his back, particularly if that which is related is not true; to kill any living creature (and even a butcher whose profession it is to slaughter yak and sheep sins in so doing, but those who buy the meat do not); to have sexual relations with the spouse of another, or with a nun or a monk because the party involved contributes to the sin committed by a celibate; to threaten children or make them cry whatever the reason; to marry a girl who is unwilling is a sin both for the husband and for the parents who arranged the marriage; to hit an animal, to fell trees, though on occasion it is inevitable, to pluck flowers or to set fire to the forest; for monks and nuns it is sin to drink too much and become intoxicated; and to cause a spirit long associated with a locality to be driven out is sin for the person who commissions the exorcising, but not for the lama who executes it.

The Sherpas' approach to moral problems reflects their great respect for the dignity and independence of the individual. Any action encroaching forcibly on this independence is considered sin. Respect for the independence of the individual is expressed also in the attitude to those known to have committed sins. Their actions are held to be their own affair, and no public notice is taken of what is recognized as a violation of the moral code. In the village of Khumjung there was an ex-monk and an ex-nun, who had gone through a form of marriage, and now lived as man and wife. Though my informants were unanimous in describing the violation of their vows of celibacy as sinful, they said that this was a matter of no concern to the villagers. The offending couple might suffer in the next world, but there was no reason why the neighbours should object. Indeed there are no signs of any overt disapproval of such or similar couples by other members of the village community.

Sherpa ideology equates knowledge and virtue. A lama's reputation of saintliness is proportionate to his learning, for the Sherpa believes that an intellectual grasp of the true doctrine must necessarily lead to correct conduct. They emphasize, however, that purity of heart is more important than a knowledge of the scriptures and the performance of elaborate and costly rites.

Although the expenditure of material wealth for religious ends can never replace purity of heart, the liberal giving away of earthly goods gives rise to admiration. Not the accumulation, but the proper utilization of wealth, lends a person prestige, and there is a certain analogy between the meritorious use of material resources, and the ideal way of utilizing accumulated *sönam*, or religious merit. Just as Sherpas expect that a rich man will on certain occasions, such as memorial feasts for

close relatives, distribute a large part of his wealth to the lamas engaged in the performance of the rites and to his co-villagers attending the celebrations, so they assume that a saintly lama, whose accumulation of *sönam* would enable him to enter Devachen, the realm of eternal bliss, will voluntarily forgo this enviable fate and accept a new incarnation in order to devote his wisdom and his saintliness to the service of humanity. The liberal expenditure of material as well as spiritual resources for the benefit of one's fellow-men represents an ideal which explains many facets of the Sherpa's social conduct. Compassion with all animate creatures is in their eyes the essence of every virtue, and selfless activity in the wider interest of humanity complements the striving for personal spiritual perfection.

4

FOREWORD TO THE MAP OF THE MOUNT EVEREST AREA

By Erwin Schneider

The ability of man to see in terms of space, to determine whether an object lies nearer to or further away from the observer, proceeds from the fact that he observes with *two* eyes. The visual rays of the eyes form an angle at the point of observation, which becomes smaller in proportion to the distance of the observed object. Where the distance between the eyes is approximately 60 mm., the angle at a finite distance is for all practical purposes so small that the visual rays can be regarded as virtually parallel. At this distance (about 200 m.), man is no longer able to see in terms of space. Haze or shade may simulate a stereoscopic effect but there is no actual spatial vision.

The modern system of surveying by means of photogrammetry is based on this faculty. In former methods of surveying, it was customary to determine a variable number of fixed points, according to the difficulty or configuration of the terrain. The rest of the terrain was then measured off and sketched in within the framework of points, the choice of the relevant details being left to the computer. In this way the details of the map were inserted without being accurately surveyed; in other words, they were interpolated. It goes without saying that the accuracy of this method varied in proportion to the intricacy of the terrain and that it was obviously least satisfactory in barren or mountainous country.

In photogrammetry, however, a predetermined number of trigonometrical points within the established framework is permitted, for they serve as indicator points for the accurate interpretation of the pictures. In the field, however, everything is accomplished as far as possible by photography, either from an aircraft (air photogrammetry) in strip formation, or from suitable points on the ground giving a good all-round panorama (terrestrial photogrammetry). For purposes of accuracy, which should be equivalent to the accuracy of the drawing (0.2 mm., breadth of stroke), the distance apart of the series of pictures must be chosen. Most satisfactory is a ratio of 1:10 between the trig. point and

the distance of this from the object to be photographed. For example, if the point which it is desired to photograph is, say, 1000 m. distant, then the same picture should be taken from two separate points about 100 m. apart. If then the left-hand picture is viewed with the left eye and the right-hand picture with the right eye, the photographed object is seen stereoscopically as though the eyes were really 100 m. apart (ratio of 1:10), or substituting this for a close object, it is as though one were looking at an object 600 mm. distant with the normal distance between the eyes of 60 mm. Where suitable equipment (such as an autograph camera) is employed, the pictures can be marked off and the marks conveyed by an optical-mechanical device on to an underlying base, thus producing the area of the picture with extreme accuracy.

The above briefly-described method of photogrammetry was employed in the survey of the Nepalese side of the Chomolongma¹ massif. During the last few decades ever-increasing regard was paid not only to the mountaineering but also to the scientific exploration of unknown mountain ranges. Maps and sketches form the basis of this work and facilitate later work in the field. The better the cartographical basis, the easier it is to carry out the geographical, geological, ethnological, botanical, glaciological, and geophysical development of the area depicted on the map. In view of the rapidly increasing 'traffic' in the respective areas, the touristic side must not be neglected. Perhaps the time is not so far distant when travel agencies will include tours to the highest mountain in the world in their itineraries.

The mountain massif known by the local inhabitants as Chomolongma, Goddess Mother of the World, is known to us as Mount Everest. This artificial nomenclature arose from the fact that the mountain was named after the Head of the Great Trigonometrical Survey of India, Sir George Everest, 1823-43. It was not so very long ago that nothing whatever was known about this peak, the highest mountain in the world. For some time, the title was claimed for Chimborazo (6310 m.) in the western Cordilleras of Ecuador, later to be deposed in favour of Gauri Sankar (7145 m.). This mountain, situated about forty miles to west-south-west of Everest, is not concealed by foothills and can be plainly seen from the south. Mount Everest, on the other hand, lies behind a high mountain chain rising to 7000 m. twenty-five miles to the south, which cuts off any view of it. This explains why it was discovered comparatively late in the history of surveying. Even today it is not an easy matter accurately to identify Everest when flying from the Indian plains to Kathmandu.

The altitude of the highest mountain in the world was determined in the middle of last century from a long way off in the Indian plains and the foothills. The distances varied between 80 and 125 miles and the

¹ See note on Tibetan place-names, p. ix

calculations involved consideration of a variety of factors, such as the curvature of the earth, terrestrial refraction, and deflection from the vertical. The two latter factors have an adverse effect upon the result, in proportion to the distance of the object. Deviation from the perpendicular is caused by the gravitational attraction of the mountain mass. This attraction of the Himalayan massif has the effect that water in a level no longer remains horizontal but is tilted in the direction of the mountain mass, which means that a theodolite cannot be placed in a horizontal position. The altitudes measured on the occasion of the first survey, varied between 8836 and 8888 m.

A few years ago a new series of measurements was carried out by the Survey of India. The nearest observation points were advanced twenty-five miles towards Everest and the results evaluated, as regards position and height of the mountain, were as follows:

27° 59' 15.9" N., 86° 55' 39.5" E., 8847.6 m. (29,028 ft.)

As there was no trig. point or cairn on the summit, various errors could affect the result, such as error in latitude and position of the point of observation, error in observation (error in reading off and wrong objective), and differing heights of the snow cover on the summit. But the figures quoted are the most accurate available today.

The cartographical determination of the mountains surrounding Everest is already fairly well advanced. Work on this first began in 1871 in Tibet. It consisted of photographs taken by Hari Ram and had to be carried out in great secrecy. The next and more accurate survey was carried out by C. H. D. Ryder in 1903, who later became head of the Survey of India. The immediate surroundings of Everest were not included in this work.

The survey of the terrain on the north side began with the first Everest reconnaissance in 1921. At that time Nepal was prohibited to all foreigners but thanks to good relations with Lhasa, a British expedition obtained permission to travel through Tibet. H. T. Morshead was the leader of the survey team. His colleague, O. E. Wheeler of the Survey of India, surveyed the terrain to the west, north, and east of Mount Everest with a primitive type of photogrammetry. He produced a dramatic report, from which can be gauged the amount of patience required and the privations to which he was exposed in order to obtain only incomplete results. The expedition arrived at the beginning of the rainy season and left towards the end of the monsoon period. Although the other side of the main chain, the lee side, was undoubtedly subject to better conditions than the south and south-west side, the cartographical work was a terrible test of patience, for Wheeler was only able to operate on a limited

number of days. It is impossible to say how many days, benumbed and soaked to the skin, he had to wait for the weather to clear up so that he might make a few observations. One can, therefore, well understand the closing sentences of his report: '... however, I must place on record that Tibet—or at least that part in which we were—is a wonderful country To Have Been In, rather than To Go To!' (*Mount Everest, Die Erkundungsfahrt*, 1921, Benno Schwabe, Basle, 1922 (out of print); Major H. T. Morshead, D.S.O., 'The Survey', p. 255; Major E. O. Wheeler, M.C., 'The Cartographical Survey', p. 266.)

This survey was supplemented by the Indian surveyor, Hari Singh, on the occasion of the third British expedition. This was once more limited to the Tibetan side of the mountain. Surveys were made on the Nepal side from 1924 to 1927 by Indian topographers. The accumulated results of all this work were incorporated in the general map of 1:253,440 (quarter-inch), now no longer available. In 1930 the Survey of India produced a half-inch map, 1:126,720 of the Everest region. This extended to the south as far as the confluence of the Dudh Kosi and the stream flowing out of the Imja Khola at the Monastery of Thyangboche; to the west as far as Tesi Lapcha at the junction of Khumbu and the Rolwaling Valley; to the north it included the non-glaciated foothills of the main chain; and to the east Kangshung Glacier and Makalu in the Khumbakarna Himal. This map is also no longer available. It showed clearly the difference between the excellent survey of the Tibetan area and the more or less sketched-in areas in Nepal, where barren territory lying above inhabited regions was largely neglected.

The immediate surroundings of the Chomolongma massif, Rongbuk Glacier, Kangshung Glacier, and the Western Cwm with Nuptse and Lhotse, were reproduced in a one-inch map (1:63,360) by the Royal Geographical Society and the Alpine Club in 1925. The representation of the terrain of this map was superbly reproduced in the style of the Siegfried Atlas by the Swiss topographer Charles Jacot-Guillarmod. Aerial photographs were also taken during the first flight over Everest in 1933. As a base the former terrestrial survey pictures were used, corrected and supplemented. The area involved was confined mainly to the south-east of Everest, including the upper Hongu Valley, the Barun Glacier, and Makalu. The result of this survey, which seemingly included everything not obscured by cloud in the aerial photographs, was a sketch-map of 1:50,000, published by the R.G.S.

In 1935 Michael Spender was working on the north side and surveyed the northern scarp of the Chomolongma massif from the Lho La to the Rapiu La by means of the photogrammetric-theodolite (point by point elaboration). The map was published by the R.G.S. and the

Himalayan Club to a scale of 1:20,000 and shows the north face of the massif in full topographical detail.

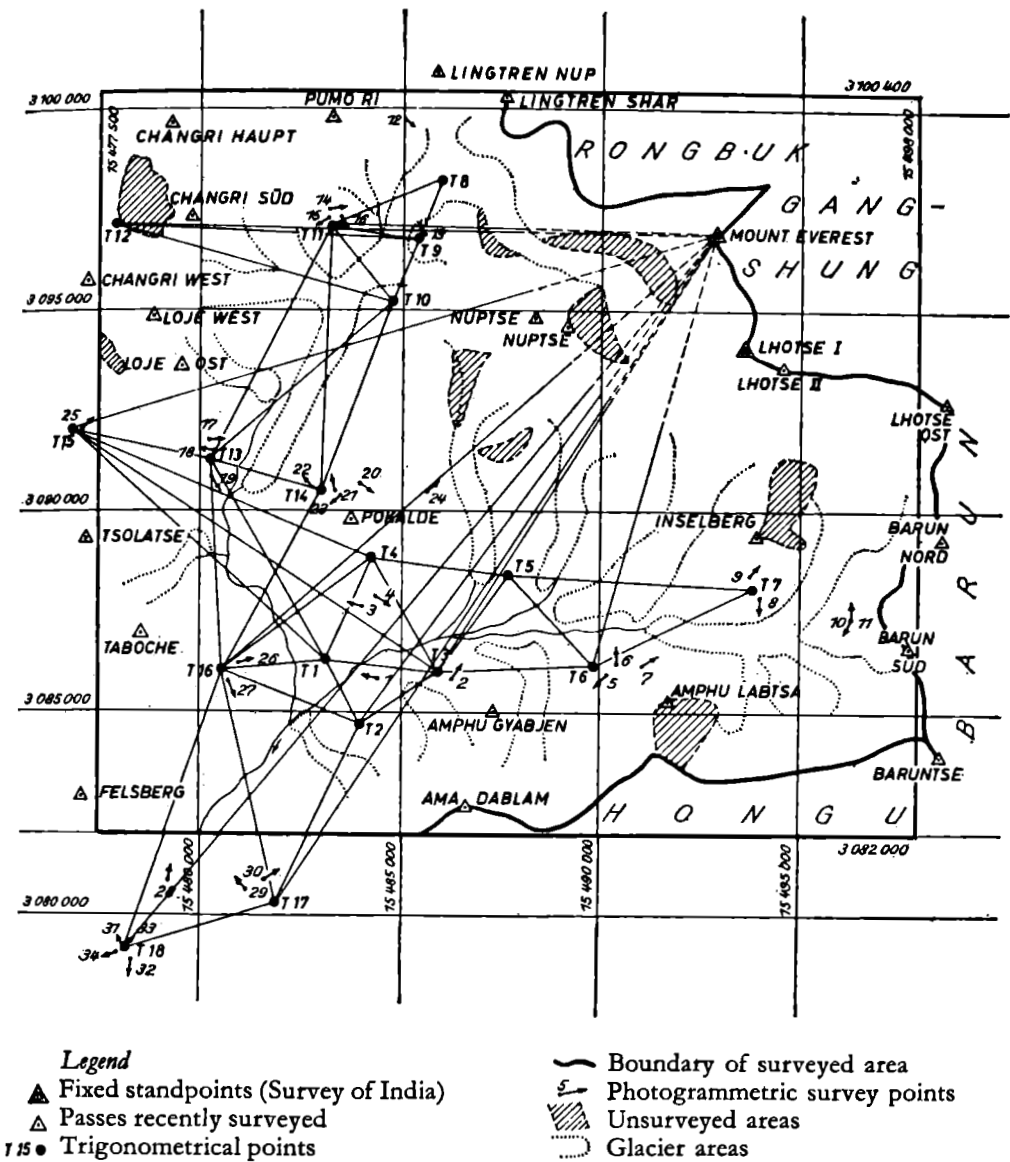
Finally, in 1958, the French Himalayan Expedition of 1954-55 brought out a sketch-map made by the geologist P. Bordet. It was reproduced to a scale of 1:50,000 and was obviously based on the above-mentioned aerial photographic map of the R.G.S., for it covered roughly the same terrain and was supplemented and corrected by ground observation. It was very well produced in every way and served as a base for the geological work of P. Bordet and M. Latreille.

Up to and including the two above-mentioned sketch-maps, it will be seen that the Tibetan side of the range and the Chomolongma massif in particular was well served with maps, whereas the south and south-west ranges and valleys of Nepal were sadly lacking in this respect; in fact, as already stated, the barren lands were sparsely delineated and largely incorrect. In order to fill in these gaps, the author of this foreword made a photogrammetric survey of the terrain on the Nepalese side of Mount Everest during the course of the International Himalayan Expedition of 1955, led by Norman G. Dyhrenfurth. A partial result of this work is the map of 1:25,000 included in this book, which was published by the Oesterreichischer Alpenverein and the Deutsche Forschungsgemeinschaft in 1957.

At the end of the successful British expedition of 1953, Charles Evans made a topographical survey of the south-west side. In the early summer of 1954 a New Zealand mountaineering party visited and surveyed the Barun Glacier area, but the work had to be broken off owing to the serious injury of the surveyor McFarlane, who fell into a crevasse. After the successful ascent of Kangchenjunga in 1955, N. Hardie remained in Khumjung until the autumn, making a round trip through the Inukhu Valley to the upper Hongu Valley and back via the Imja Khola. The cartographical results of this expedition have not as yet been published.

The trig. points mentioned at the beginning of this chapter as being essential to any photogrammetrical survey, were disclosed to the author by the Survey of India in 1955. They are the co-ordinates (position and height) of the following mountains: Mount Everest, Lhotse, Makalu, Cho Oyu, Gaychung Kang, Kwangde, Chamlang, Karyolung, and Chomo Lonzo. The framework of these mountain summits serves as an initial base for the ensuing survey work, so that both determination of latitude and base measurement are rendered superfluous. Right at the beginning the author had a stroke of luck for on the very first day he was able to observe, from a single point on a ridge above the hamlet of Dingboche, the following peaks: Cho Oyu, Lhotse, Makalu, Karjolung, and Kwangde, thus ensuring a satisfactory start to his work without

Grid Sketch



much labour. By a further lucky chance there happened to be two large chortens standing on the top of this ridge, forming ideal trigonometrical signals. One of these was used as the central trig. point for the area and surveying began and ended at this spot.

The weather was the greatest stumbling-block to the successful prosecution of the work. In early summer, before the monsoon, precipitation is small but on the other hand the mountains are largely covered with cloud or at least are very hazy. During the spring of 1955, work was only possible on eight days, of which only five were full working

days. On the remaining three, work had to be abandoned before midday as thick cloud rolling up from the valleys obscured vision.

During the rainy season systematic work on the lee side of the range was hopeless. Now and again it cleared up for a few hours in the early morning but not sufficiently to enable satisfactory survey work to be carried out. The author, therefore, waited impatiently for the legendary autumn weather. It did not arrive before the end of September and the first few days constituted a great strain on the patience. Anything up to a couple of hours after sunrise, the terrain was rapidly covered with cloud and work was over for the day. However, the weather gradually improved, though there were occasional setbacks when it snowed all day. Finally, by November, it was possible to reckon upon getting in half a day's work, but operations had to be concluded by midday at the latest, in order to obviate a second climb up to the trig. point. As the highest points on the ridge were not used, gale-force winds which produce snow plumes on the high summits were rarely experienced. The altitudes of the trig. points varied between 500 and 1000 m. On many occasions the author left camp in the middle of the night; the work of measuring angles was frequently concluded before sunrise and the photogrammetrical survey was finished by early morning. Towards the end of November the race against the clouds was no longer so exacting, but the cold in the evening, night, and early morning was unpleasant.

The terrain consisted of treeless, barren land and was therefore ideal for photogrammetry. Unfortunately it was rarely possible to climb up to the ridges from which surveying could be carried out on both sides, for the terrain was too difficult, and the summits too high and the results did not warrant the expenditure of time and energy. By the time the ridge had been reached, it was so late that the clouds had already obscured everything. Based on his experience, the author considers the best time to carry out survey work in the eastern Himalayas is from the middle of October to the middle of December, for at that time the work is only likely to be subjected to small fluctuations in the weather.

The survey of the accompanying map occupied twenty full working days, during which time 146 observations were made from which the map was finally produced. The highest trig. point of the entire map was a few metres below 6000 m., indeed most of them were above 5000 m. My assistants were Gaja Nanda Vaidya from Kathmandu, who inscribed the survey points in the angle books, five Sherpas from Namche Bazar, Khumjung and Pangboche, and two Sherpani. Without their aid the author would never have been able to complete the survey and their employment was decisive for the rapid conclusion of the whole operation.

The working arrangements were briefly as follows: the survey party left camp in the middle of the night and ascended to the sphere of operations, where surveying was usually carried on until midday or early afternoon. In the meantime, the main body shifted the camp close to the next sphere of operations and the working party returned to the new camp site. Owing to lack of time it was not possible to place signals *in situ* beforehand, and the observations points were selected by means of conspicuous rock or other formations even before they had been reached. This demanded a good sense of direction and terrain and it was only by luck that there were no errors. In this manner a compact triangulation network was surveyed. The signals consisted of cairns about two metres in height and beautifully constructed, for the Sherpas are past masters in building without cement or other binding agents. Any gaps, unavoidable in the short time available, were filled in afterwards by normal photographic methods. Parts of the Rongbuk Glacier, the Kangchung Glacier, the Barun Glacier, and the upper Hongu Valley were completed in this way by means of extraneous photographs. It would not, however, escape a trained observer even without knowledge of this data (given in the legend on the edge of the map), that the terrain in question had not been accurately surveyed by photogrammetry.

Altitudes have been inserted both in metres and feet, so that those who are not at home with the former can use the map without difficulty. Recently the metric system has been introduced into India. Contours are at 20 m. intervals, with stressed contours every 100 m., only on very steep ground where space is lacking are the 20-m. contours left out. The production is similar to that of any similar map made in Europe to the same scale. It is thus possible to make a direct comparison between the terrain in our Alps and the massif containing the highest mountain in the world. One glance will suffice to determine the magnitude of the Chomolongma massif.

The title of the map is 'Mahalungur Himal', the 'Snow Mountain of the Great Ape'. It is quite plain that the original Indian topographer translated the native names from either the Sherpa or Tibetan dialect into his own language. The name refers to the fabulous snowman (Kang Mi or Yeti) which is said to abound in these parts and which has left many footprints without ever having been seen, at least by any reliable witness.

As far as possible, only actual local names of long standing have been inserted in the map, with the exception of some artificial names which have been in use for many years. Thus, the barren terrain is left blank—of great advantage for the presentation of the map. An exception had to be made with names of glaciers, for the purpose of more exact determination

of a locality in any future glaciological work. The Tibetans do not name their glaciers, so it is not feasible to render the word 'glacier' by the words 'Kang' or 'Gang' (snow, ice). 'Kharum', which is occasionally employed, is not familiar to the Sherpas. For this reason the English word 'glacier' has been adopted, as English is still the second official language in India. Artificial nomenclature of glaciers, therefore, emanated either from surrounding mountains or neighbouring pastures. Names of villages and settlements were evolved by Fritz Müller in 1956 and by the author in 1955 in accordance with spelling adopted by the Survey of India. The spelling was also checked by Peter Aufschnaiter who spent years in Tibet and now works in Nepal.

The necessary calculations took about a month to work out. First of all the closed triangulation chain was calculated, followed by the determination of the thirty-one photogrammetrical points (base lines); finally the main network of freshly surveyed points, most of them outstanding peaks, was computed. All heights were freshly calculated (with the sole exception of the height of Lhotse, which was accepted) in relation to height of Mount Everest. The evaluation of the results of the calculations were reproduced in twelve sketch-maps of 36 square kilometres each, to a scale of 1:10,000. Accuracy is within the normal tolerance of $\pm$ or $- 0.2$ mm. The total time involved amounted to 600 hours.

After the work was completed and the map produced, an error was discovered. The pasture of Chukhung was drawn in the wrong place, a fact which was pointed out by users of the map. The huts on this pasture are concealed behind the terminal moraine of the Lhotse Glacier in the Imja Khola. The terrain had been accurately surveyed but the huts could not be seen in the two pictures, due to the bad light of early morning. The locality was therefore pinpointed by Fritz Müller and the author from the former's sketches; unfortunately erroneously. Chukhung therefore lies a few hundred metres to the north and at an altitude of approximately 4800 m.

The Chakri La in the north-west section of the map on the ridge between the Changri Nup and Guanara Glaciers is not named and only appears as a height (5690 m., the lowest point on the ridge). This was intentional as the north-west side of the ridge towards the Guanara Glacier is precipitous and impracticable. Another pass which can be crossed lies a little to the north and somewhat higher, the altitude of which also appears on the map.

At the end of the survey in May 1957, the twelve sketch-maps to the scale of 1:10,000 were reduced to 1:25,000 and coalesced. The publication of the map had been fixed for 1 November 1957, so there only

remained five months for Fritz Ebster to turn the sketches into a map. The simplest method of production had to be adopted, not only to reduce the cost but also to produce the map within the stated time. To this end the contours were retained and not drawn in afresh or engraved, thereby saving a considerable amount of valuable time. The three colour prints, black, blue and brown were then produced. The map was to be in three colours separately applied.

Ebster was familiar with the terrain as a whole and it was not necessary for him to begin with details, as is the case with lithographic printing or glass engraving (the latest method). The two latter methods were not used owing to lack of time and the high cost. The prints were in three colours and the final technical process involved drawing with Indian ink on astralon. After completion of the survey, each pair of pictures was elaborated in full detail and drawn in. In this manner of representation Ebster retained the contours even in rocky terrain, the rock structure being sketched in on top. This method differed from that customary in the Alps, in that the rocks were drawn in over the underlying blue contour lines. The reason for this was that these excessively steep slopes consisted more of ice than of rock. The cliffs of Ama Dablam are a good example of this. Green hatching was employed for the small amount of forest and juniper scrub in the south-west portion of the map, just at the point where the highest permanent dwellings of Pangboche encroach on the 4000-m. contour line at the edge of the map.

In order to emphasize the clarity of the map three further types of hatching were introduced: a light ochre for overgrown land, plastic shading for moraines and other barren terrain, and blue shading for glaciers. Finally the tints were toned in together by Ebster and finished off by the offset process. The map was published in November 1957 as expected, two years after completion of the field work.

I would like to end this foreword with an amplification of the phrase used by O. E. Wheeler in closing his report, and quoted on page 185: If the right time is chosen, the country round Mount Everest with its friendly inhabitants is not only a region To Have Been In but certainly one To Return To.

TABLE 1

X and Y are Gauss co-ordinates in the meridian range $15, 90^{\circ} E = Y = 15,500,000$. Starting Altitude: Mount Everest = 29,028 feet = 8847.6 metres. 1 foot = 0.304797 metres. 1 metre = 3.280870 feet.

Altitudes and geographical co-ordinates supplied by The Survey of India

No.		N	E	Y (right)	X (high)	Height (metres)	Height (feet)
		° ' "	° ' "				
1	Cho Oyu	28 05 32	86 39 51	15,466,998.80	3,108,402.30	8153.30	26,750
2	Gyachung Kang	28 05 52	86 44 41	15,474,916.00	3,108,998.60	7921.70	24,990
3	Chomolongma (Mount Everest)	27 59 15.9	86 55 39.5	15,492,882.45	3,096,782.40	8847.60	29,028
4	Lhotse I	27 57 43	86 56 10	15,493,714.30	3,093,922.50	8500.80	27,890
5	Makalu	27 53 23	87 05 29	15,508,997.30	3,085,921.50	8470.30	27,790
6	Chomolonzö	27 55 47	87 06 44	15,511,044.20	3,090,355.40	7815.00	25,640
7	Gauri Sankar	27 57 52	86 20 16	15,434,848.10	3,094,374.40	7144.40	23,440
8	Chamlang	27 46 23.9	86 58 55	15,498,220.50	3,073,018.60	7317.00	24,006
9	Naulekh	27 41 12.6	86 54 18.1	15,490,632.60	3,063,440.70	6359.60	20,865
10	Mera	27 42 33.1	86 52 15	15,487,262.50	3,065,921.40	6473.50	21,238
11	Kwangde	27 47 32.5	86 38 42.2	15,465,024.30	3,075,180.50	6187.10	20,299
12	Numbur	27 45 15	86 34 30.6	15,458,122.90	3,070,970.10	6956.70	22,824
13	Karjolung	27 43 54.2	86 36 56	15,462,096.40	3,068,470.10	6511.10	21,362

TABLE 2

Main net, triangulation points, location. Height above sea-level

No.	Y (right)	X (high)	Height (metres)	Height (feet)	Location
T1. Dingpoche	15,483,157.80	3,086,249.60	4412.00	14,475	West chorten above Dingpoche on path to Dusa pasture
T2. Above Tuo	15,484,453.50	3,084,434.70	5045.00	15,377	Crag on NW ridge of Ama Dablam
T3. Above Shanjo	15,485,539.90	3,085,964.00	4743.00	15,561	Cairn on extreme right lateral moraine of Tuo Glacier
T4. Nanga Dزونگ	15,484,302.80	3,088,775.60	5638.00	18,498	Rock pinnacle on ridge between Tsola and Imja Khola
T5. Above Bibre	15,487,720.25	3,088,373.40	5043.00	15,370	Cairn on spur E of head of snout of Nuptse Glacier
T6. Chukhung	15,489,886.40	3,086,058.20	5395.00	17,700	Cairn on crag SE of and above Chukhung pasture
T7. Monadnock	15,493,904.40	3,087,903.10	5494.00	18,025	Cairn on ridge N of and above junction Lhotse-Shar and Imja Glaciers

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T8. Khumbu	15,486,003.80	3,098,187.80	5356.00	17,572	Cairn on head of moraine above Base Camp on Khumbu Glacier
T9. Nuptse Spur N.	15,485,429.40	3,096,690.00	5456.00	17,900	Cairn on rock tower NW below Nuptse
T10. Nuptse Spur S.	15,484,794.60	3,095,150.00	5649.00	18,534	Cairn on West tower on ridge below Nuptse, opposite Changri Glacier
T11. <i>Below</i> Pumo Ri	15,483,282.00	3,097,067.30	5545.00	18,192	Cairn on ridge S of and below Pumo Ri
T12. <i>Guanara</i>	15,477,924.60	3,097,085.80	5966.40	19,574	Cairn on crag on watershed of Changri and Guanara Glaciers
T13. <i>Above</i> Lobuche	15,480,288.40	3,091,247.80	5245.00	17,208	Cairn on ridge SW of and above Lobuche pasture
T14. <i>Below</i> Pokalde	15,482,966.00	3,090,508.50	5516.00	18,097	Cairn on crag E of and above Lingten
T15. <i>Above</i> Dzongla	15,476,077.00	3,091,443.50	5750.00	18,865	Rock tower on watershed W of Tsola Khola
T16. <i>Above</i> Samso Chopo	15,480,594.40	3,085,954.80	5140.00	16,864	Cairn on crag E of and below Taboche
T17. <i>Above</i> Mingbo	15,481,928.80	3,080,353.20	5197.00	17,051	Cairn on rock peak above Mingbo and W of the Nare Khola
T18. <i>Above</i> Thyangboche	15,478,170.30	3,079,133.40	4558.00	14,954	Cairn on rock shoulder above Thyangboche Monastery

TABLE 3

New Surveyed Points in the Main Network

<i>Name</i>	<i>Y (right)</i>	<i>X (high)</i>	<i>Height (metres)</i>	<i>Height (feet)</i>	<i>Location</i>
Rock peak above Pangboche	15,477,083	3,082,812	5220	17,126	Point on Taboche SW ridge, W of and above Pangboche
Chang Ri, West	15,477,060	3,095,671	6169	20,240	Highest summit between Tsola Khola and Changri Glacier
Tsolatse	15,477,215	3,089,349	6440	21,129	Peak above Tsola lake
Taboche	15,478,426	3,086,785	6542	21,463	Highest summit N of and above Pangboche
Loje, West	15,478,826	3,094,803	6145	20,161	W of and above Lobuche Glacier

Loje, East	15,479,623	3,093,607	6119	20,076	W of and above Lobuche
Main summit of Chang Ri	15,497,360	3,099,596	6853	22,484	Highest peak N of Changri Glacier
South Spur of Chang Ri	15,479,745	3,097,257	6035	19,800	Southernmost spur of Chang Ri range
West Summit of Kangtega	15,481,556	3,075,515	6718	22,041	Ice pinnacle S of Thyangboche
Pumo Ri	15,483,264	3,099,753	7145	23,442	Highest peak in main chain between Everest and Gyachung Kang
Pokalde	15,483,869	3,089,858	5806	19,049	Highest peak above T ₁₄ (Table 2)
Lingtren Nup	15,485,846	3,101,049	6697	21,972	On main chain N of Pumo Ri
Lingtren Shar	15,487,702	3,100,347	6640	21,785	On main chain W of Lho La
Ama Dablam	15,486,641	3,082,761	6856	22,494	N peak of summit ridge
Ambu Gjabjen	15,487,364	3,084,973	5650	18,537	Rock peak N of Ama Dablam
West Shoulder of Nuptse	15,488,306	3,094,870	7745	25,410	Westernmost summit of Nuptse ridge
Main Summit of Nuptse	15,489,143	3,094,527	7879	25,850	Highest point on Nuptse ridge
West Summit of Amphu Labtsa	15,491,755	3,085,208	6238	20,466	On watershed of Imja Hongu, E of Chukhung
Monadnock	15,493,975	3,089,403	6189	20,305	Highest summit between Lhotse and Lhotse Shar Glaciers
Lhotse Shar (Lhotse 2)	15,494,607	3,093,520	8383	27,504	E summit of Lhotse
South Summit of Barun	15,497,821	3,086,536	6677	21,906	N of lowest dip in watershed Imja-Barun
North Summit of Barun	15,498,560	3,089,257	6734	22,093	Watershed Imja-Barun
Baruntse (P. 39)	15,498,551	3,083,857	7220	23,688	On watershed, 1 km. SE of junction of Imja Hongu-Barun
East Shoulder of Lhotse	15,498,784	3,092,595	7502	24,613	On main ridge, junction of Imja-Gangchung and Barun Valleys

TABLE 4

Base Line References. Co-ordinates refer to the left point

HTAF = Height of photo-theodolite lens, li = left, re = right

K = Convergence of pictures

Amax = Maximum effective distance in metres for the respective base lines

No.	Y (right)	X (high)	HTAF	Base	Deviation	K	Amax	Location
1	15,484,559	3,085,769	4662	308.30	35 li-0.35 re	3	6000	Tuo Glacier

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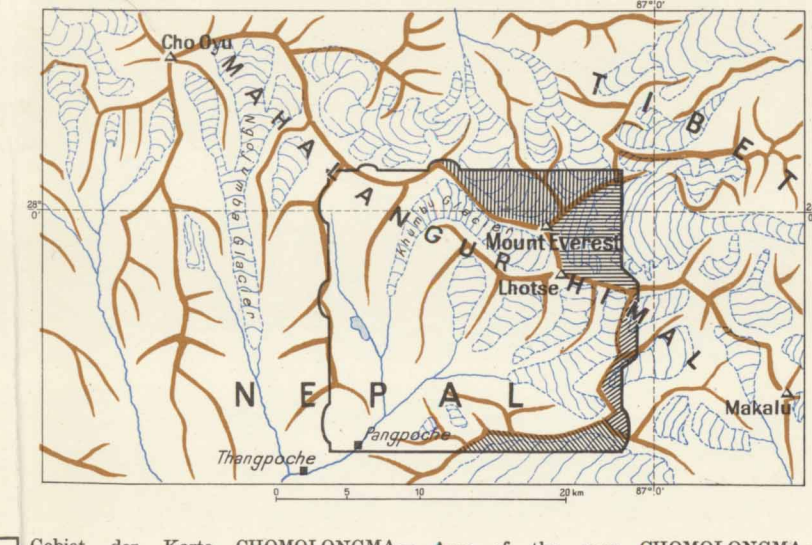
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2	15,485,954	3,085,994	4765	624.60	35 li-0-35 re	5	11000	Tuo moraine near T ₃ (Table 2)
3	15,483,738	3,087,503	4961	475.35	35 li-0-35 re	5	8000	Above Dingpoche Gompa
4	15,484,301	3,087,824	5226	443.60	35 li-0-35 re	3	8000	Below Nanga Dzong, T ₄
5	15,490,214	3,085,833	5348	159.40	6 re	1	4500	Above Chukhung, near T ₆
6	15,490,458	3,086,158	5308	473.00	35 li-0-35 re	3	9000	Above Chukhung, near T ₆
7	15,490,983	3,086,420	5232	320.60	0	4	5000	Above Chukhung, near T ₆
8	15,493,897	3,087,870	5481	437.90	35 li-0-35 re	3	6000	On Monadnock, near T ₇
9	15,493,871	3,088,042	5519	242.90	25 li 25 re	2	6000	On Monadnock, near T ₇
10	15,496,320	3,087,375	5680	230.40	30 li	3	5000	Below S summit of Barun
11	15,496,320	3,087,375	5680	260.30	20 re	3	4500	Below S summit of Barun
12	15,485,050	3,099,800	5750	460.00	12 re	3	10000	Below Pumo Ri (Leica)
13	15,485,429	3,096,690	5457	336.10	35 li-0-35 re	3	5000	Below Nuptse, near T ₉
14	15,483,375	3,097,623	5634	563.20	30 li 15 re	3	9000	Below Pumo Ri, near T ₁₁
15	15,483,282	3,097,067	5547	395.80	35 li 15 re	3	6000	Below Pumo Ri, near T ₁₁
16	15,483,679	3,097,191	5427	415.30	12 li 33 re	3	5000	Below Pumo Ri, near T ₁₁
17	15,480,173	3,091,601	5258	320.00	16 li 34 re	4	6000	Above Lobuche, near T ₁₃
18	15,480,266	3,091,411	5250	211.25	30 li 20 re	3	4000	Above Lobuche, near T ₁₃
19	15,480,389	3,091,048	5072	247.10	20 li 30 re	3	5000	Above Lobuche, near T ₁₃
20	15,484,137	3,090,454	5562	213.20	30 li 20 re	3	5000	Pass below Pokalde
21	15,482,966	3,090,509	5517	1048.50	30 li	5	12000	Below Pokalde, near T ₁₄
22	15,482,902	3,090,527	5497	272.05	35 li-0-35 re	3	5000	Below Pokalde, near T ₁₄
23	15,483,272	3,090,299	5538	370.65	30 re	3	6000	Below Pokalde, near T ₁₄
24	15,485,632	3,090,587	5657	265.30	30 li 20 re	4	4500	Rock ridge W of and above Nuptse Glacier
25	15,476,731	3,091,933	5142	281.00	35 li-0-35 re	3	4500	Below Tsola Khola, T ₁₅
26	15,480,726	3,086,060	5077	219.05	35 li-0-35 re	3	5000	Below Tsoatse, near T ₁₆
27	15,480,993	3,085,573	4938	614.50	35 li-0-35 re	3	11000	Below Tsoatse, near T ₁₆
28	15,479,473	3,081,202	4027	218.40	25 li 25 re	5	4000	Opposite Pangboche
29	15,481,647	3,081,533	4583	311.10	35 li-0-35 re	3	6000	Below Nare Khola, T ₁₇
30	15,481,880	3,081,741	4626	319.90	35 li-0-35 re	4	5000	Above Mingbo, near T ₁₇
31	15,478,211	3,079,156	4560	438.10	35 li-0-35 re	3	7000	Above Thyangboche, near T ₁₈
32	15,478,351	3,079,090	4559	286.20	33 li	2	4000	Above Thyangboche, near T ₁₈
33	15,478,170	3,079,133	4559	286.20	29 li	3	5000	Above Thyangboche, near T ₁₈
34	15,478,351	3,079,090	4559	303.50	25 re	3	6000	Above Thyangboche, near T ₁₈

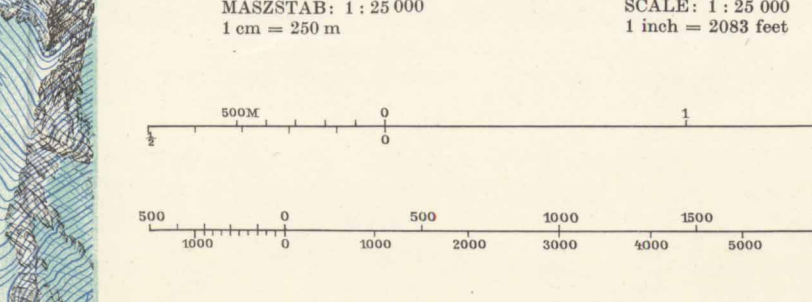


Triangulation starting points from the SURVEY OF INDIA. Cho Oyu-Gangshung Kang-Mount Everest. Lhotse-Makalu-Chomolungma-Kangshung. Triangulation starting points from the SURVEY OF INDIA. Cho Oyu-Gangshung Kang-Mount Everest. Lhotse-Makalu-Chomolungma-Kangshung. Triangulation starting points from the SURVEY OF INDIA. Cho Oyu-Gangshung Kang-Mount Everest. Lhotse-Makalu-Chomolungma-Kangshung.

Die Namen wurden erhoben 1935 von E. von Erben-Schneider und 1936 von Fritz Müller. Die Namen sind gegeben nach der Schreibweise der SURVEY OF INDIA. The names were raised 1935 by E. von Erben-Schneider and 1936 by Fritz Müller. The names are given according to the way of writing adopted by the SURVEY OF INDIA.



Geht der Karte CHOMOLONGMA= MOUNT EVEREST. Area of the map CHOMOLONGMA= MOUNT EVEREST. Geht der Karte CHOMOLONGMA= MOUNT EVEREST. Area of the map CHOMOLONGMA= MOUNT EVEREST.

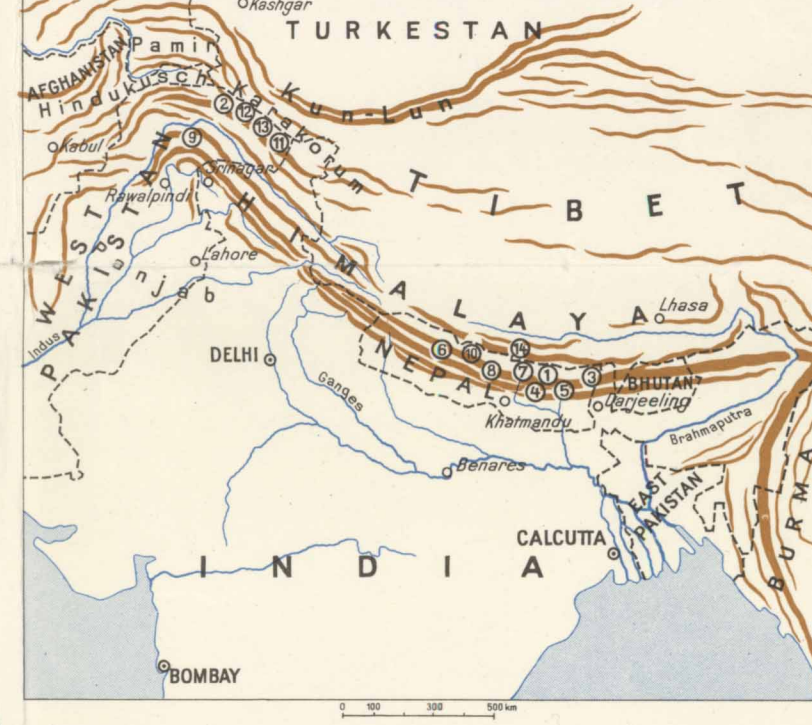


Höhenlinienabstände bei verschiedener Neigung: Contour intervals at different grades. Höhenlinienabstände bei verschiedener Neigung: Contour intervals at different grades.

Umrechnung der Höhen von 4000 m bis 8000 m in englische Fuß. Metre measure converted into feet.

Metre	Feet
4000	13121
4100	13451
4200	13778
4300	14104
4400	14430
4500	14756
4600	15082
4700	15408
4800	15734
4900	16060
5000	16386
5100	16712
5200	17038
5300	17364
5400	17690
5500	18016
5600	18342
5700	18668
5800	18994
5900	19320
6000	19646
6100	19972
6200	20298
6300	20624
6400	20950
6500	21276
6600	21602
6700	21928
6800	22254
6900	22580
7000	22906
7100	23232
7200	23558
7300	23884
7400	24210
7500	24536
7600	24862
7700	25188
7800	25514
7900	25840
8000	26166

ZEICHENERKLÄRUNG: REFERENCES: Symbols for various geographical features like rivers, lakes, and mountains.



1 Mount Everest 29035 ft. 2 K 28111 ft. 3 Kangshung Kang 28155 ft. 4 Lhotse 28168 ft. 5 Lhotse Shari 27800 ft. 6 Makalu 28251 ft. 7 Cho Oyu 28251 ft. 8 Mawla 28251 ft. 9 Nanga Parbat 28251 ft. 10 Annapurna 28251 ft. 11 Dhaulagiri 28251 ft. 12 Broad Peak 28251 ft. 13 Gasherbrum II 28251 ft. 14 Sika Pargua 28251 ft.

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